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Contents

	PAGE
Works Metallurgy	57
Book Reviews	58
I.N.C. Director Appointed	58
Random Shots	58
Effect of Elevated Temperatures on Steel Sand Mixtures	59
Beaton Tuyeres	62
Monolithic Linings for Cupolas	63
Moulding a Balance-Wheel in Loam	64
Mechanical Properties of Pure Silicon	64
Magnetic Determination of Carbon	65
Electric Steels	66
Diaries and Calendars for 1940	66
Founders' Forum	67
Centenaries in the Iron and Steel Industry	67
The Week's News in Brief	68
Trade Talk	68
Personal	68
Obituary	68
Contracts Open	68
Forthcoming Events	68
Raw Material Markets	70

Works Metallurgy

We were unfortunately unable to be present at last Thursday's meeting of the London Section of the Institute of Metals, which was called for the purpose of discussing "Works Metallurgy." If we had participated, we might have made a contribution along the following lines: Primarily we know of no type of metallurgy which does not demand a workshop for its prosecution, except, of course, where the plant is so big that it has to be housed in the open air, but it still remains part and parcel of a works. This being so, it would appear that the object of the discussion was to ascertain in what directions a works metallurgist could make contributions to the better conduct of an industrial concern. The activities of any manufacturing undertaking embrace buying, manufacturing and selling, and the metallurgist should be equally active in each of these sections. His interest in the buying department is to set out clearly the nature of the material to be bought, and to supply reports on the behaviour of each consignment. Furthermore, he must investigate all offers of alternative sources of supply and substitute materials. To be of real service, the metallurgist must familiarise himself with market prices, so that he can intelligently discuss with the buyer and departmental heads the question of stocks and market trends.

As no metallurgical development is of any real worth until it is placed in the hands of the working man, it is the obvious job of the metallurgist to teach the operatives the fundamentals. We well remember seeing the staff in charge of a 3-ton electric steel-melting furnace fooling around whilst conditions were going from bad to worse. An attempt was being made to create a white finishing slag, but conditions were such that it was a thin black watery slag. Every few minutes, either the metallurgist or the melter would add one or two shovels of lime without effect. Our advice was sought finally, which was given in the form of the following questions: What percentage of lime should the desired slag carry? What percentage is the present slag carrying? What weight of slag is the metal carrying now that it is so strongly diluted with droppings from the roof? How much does a shovelful of lime weigh? The result was an addition of about a hundredweight of lime, and within ten minutes the conditions were reasonably normal. The metallurgist knew all the necessary facts, but was apparently unable to apply simple chemical arithmetic.

This simple illustration indicates how the metallurgist should, but does not always, use his professional knowledge. An important duty is the recording of process results in such a manner that (1) standard practice can be maintained, and (2) deviations from this can be rapidly ascertained and corrected. Properly-made records will help in planning production. Exact knowledge of the life of a furnace, a roll or a die is of fundamental importance in maintaining the production of a factory at an efficient level. It should be clearly understood that the works metallurgist, if he be worth his salt, should not also occupy the position of works chemist. If the concern is small, then he should insist on the laboratory work being done by a separate company. By spending overmuch time in a laboratory, the metallurgist loses touch with the realities of his profession, which is the control of the conduct of metallurgical processes. One particularly successful works metallurgist controlling an enterprise employing over a thousand workpeople has no chemical laboratory. He relies on suppliers' analyses, reinforced by metallographic and physical work.

It is more than probable that the metallurgist's work most appreciated by the board of directors in peacetime is the help given with sales. Here he should help the sales manager by arranging talks and demonstrations to the staff, emphasising the control instituted to achieve a high standard. He should advise the advertising manager in the drawing up of his copy, so that the properties of the products sold will be correctly described and the worthwhile ones stressed.

The works metallurgist has also a personal duty to each executive officer by acting as his consultant. Mr. Francis Rowe only last week, in his review of the steel founding industry, pointed out in these columns how by installing electric heat-treatment ovens a better load could be imposed on the system, thereby lightening the problems of the electrical engineer.

There is no department of a works, be it transport, new constructions, maintenance, or welfare, where the help of the metallurgist cannot be given. By affording such assistance, he will receive in return much useful help. There should be a realisation by the metallurgist immediately on his appointment to an executive position that only a very small part of his thought-output will be related to metallurgy. If such matters could be analysed, it would probably be found that it was less than one per cent. The balance will be taken up with commercial matters, industrial legislation, patents, welfare, defects, planning, costing, and his private affairs. Yet because he has made metallurgy his profession, an endeavour should be made to ensure that the whole concern, from the chairman to the day labourer, must be "metallurgy conscious." This will never be attained by "blinding the management with science," but by real co-operation.

C

Book Reviews

The Quality of Coke. By R. A. Mott, D.Sc., and R. V. Wheeler, D.Sc. Published by Chapman & Hall, Limited, 11, Henrietta Street, Covent Garden, London, W.C.2. Price 36s. net.

This memoir may well constitute a Wheeler Memorial Volume, for it was ready to be issued at the time of the lamented death of the distinguished scientist, who was its joint creator. Prof. Wheeler initiated the Midland Coke Research Committee, which has for its principal object the improvement of the quality of blast-furnace coke made in the Midland area, and the experimental work was centred in him at the fuel laboratory in Sheffield.

The present volume constitutes the Second Report of this Committee, and records work completed up to the end of 1937, so that as a research publication it is already three years old. The words "blast-furnace coke" and "research report" effectively indicate its scope, for its 464 handsome pages are packed with details regarding fundamental studies of the properties of coal and the formation of coke, of empirical tests on the effect of different variables on coke quality, of careful standardisation of old and new methods of testing coal and coke, and of large-scale tests on the use of selected varieties of coke in blast furnaces. Part III on the formation of coke is particularly interesting to the scientific reader, and Part IV concerned with improving the quality of coke contains some well-illustrated experimental records. The authors say that they have been able to define fairly precisely the advantages of blending coal with coke dust, and describe the valuable effect of the presence of durain and fusain in coking coal. It may be remarked at once that there is no air of finality about this book, and it may even be questioned whether its actual title is absolutely representative of the subject matter.

Both the manufacturer of blast-furnace coke and the iron smelter will presumably appreciate all the details sintered together into this report, but considering the Committee's main objective one must not expect too much attention being devoted to the foundry point of view. The scientific producer of foundry coke will be interested in Parts III and IV in a general way, but such questions as the merits of beehive *versus* by-product coke are not dealt with beyond a mention that the former is amongst the least reactive of coke materials. The foundryman who spends his thirty-six shillings in the hopes of buying cut and dried information regarding the quality of coke to give better working of his cupola is likely to be disappointed. Let us accompany him on his first pilgrimage within the present volume.

On page 6, advice is epitomised in the three-point recommendation to use a hard unreactive coke of graded size. Regarding the last point, however, an experiment on page 36 shows that ungraded coke was superior to graded. It is very properly added that had this particular material been somewhat larger, then grading might have been advantageous. Coke of fairly large size is therefore advocated. Next we must find what is understood by a hard coke, and it is indicated on page 7 that resistance to shatter and resistance to abrasion are meant. An exhaustive analysis of the standard shatter test is provided, but no actual values are laid down to advise us about the quality of cupola coke. The Cochrane and the Sheffield abradability tests are also fully discussed, and it is suggested that they show sufficient relationship to the shatter test to indicate that all three measure the same property of coke. Presumably, therefore, there is no need for all of them, and this view is supported by the chapter on a proposed specification for coke wherein only the 1½-in. shatter test value, together with the moisture and ash contents, is utilised. Incidentally it is pointed out that a rigid specification for metallurgical coke is not possible. This is a bleak outlook!

So much for hardness; now for reactivity. The term reactivity is not fully defined, and therefore cannot be estimated in any absolute sense. The many laboratory tests so far designed to deal with it are of no help in determining the quality of cupola coke. On page 133 we learn that the most important factor affecting the general reactivity of a high-temperature coke is its size, and when Meunier is quoted to the effect that reactivity is independent of size, we are informed that he only used small sizes. If the reader works out for himself the implications of what is written in page 140, he presumably will arrive at the conclusion that a large size means low reactivity. Advice about cupola coke, therefore, boils down to this: use coke with a high (unspecified) shatter index and graded so as to be of large size. Very probably, however, the cokes of large size are those which have a high shatter index and have survived the breakage associated with manufacture and transport. And so, shorn of its learning, we would be left with the highly simplified recommendation to use cupola coke of high shatter index. By comparison, the conclusions on page 167 governing coke for good combustion in open grates appear to be precise and helpful.

It is doubtful whether the practice is to be recommended of releasing under a snappy title research reports such as the one under review. The publication is necessarily tied down to the research programme of the organising body and its progress, and therefore has difficulty in being fully comprehensive. H. O'NEILL.

Metal Working Tools and their Uses. By Percival Marshall. Published by Percival Marshall & Company, Limited, 60, Kingsway, London, W.C.2. Price 1s. 6d.

This practical handbook for amateur mechanics and apprentice engineers can be thoroughly recommended. It is a new edition which has been revised and enlarged.

Micrometers, Slide Gauges and Calipers. By Alfred W. Marshall and George Gentry. Published by Percival Marshall & Company, Limited, 60, Kingsway, London, W.C.2. Price 2s.

This handbook is written mainly for the amateur mechanic. Its popularity is shown by the appearance of this new and revised edition.

I.N.C. Director Appointed

Mr. W. R. Blair, M.C., LL.B., has accepted office as Director of the Ironfounders' National Committee, and entered on his new duties at the beginning of the year. His office is at Orchard House, Orchard Street, London, W.1. From the outbreak of war until the end of last year he was acting as assistant to Mr. C. Bigg, the Director of Iron Castings at Steel House.

Mr. Blair's name is well known among manufacturers in the light castings section of the foundry industry, with whom, in his capacity as Chief Executive Officer of the British Ironfounders' Association, he has been closely associated for many years. It is his desire that the relationships which he hopes to establish with ironfounders in the wider sphere of activity upon which he is entering will be as happy and fruitful as they have been in his work for the light castings section.

Mr. Blair will continue to exercise supervision over the work of the British Ironfounders' Association and other organisations for which he acts as executive head, so that while he hopes to make many new friends, he will not lose touch with the old. We wish Mr. Blair every success in his new work.

Random Shots

Medals for conspicuous bravery are already being awarded in the Services, and it is expected that such a medal will shortly be bestowed upon the courageous restaurateur who, on the first day of rationing, announced on his luncheon menu, "Bread and Margarine Pudding."

* * *

Apropos of the above paragraph, Mr. H. Shepherd, in his December letter to the members of the East Anglian Section of the Institute of British Foundrymen, quotes a wise saying which admonishes the reader to "Take any amount of trouble to know—knowledge impresses; guessing always depresses." Sure enough, it is always depressing to suspect that one is being palmed off with a substitute, but how impressive is the bold and simple announcement that the Bread and Butter Pudding is in reality made with margarine!

* * *

Incidentally, whilst on this subject of butter and its now familiar substitute, the other day two foundrymen were discussing the relative merits of each. Both agreed that margarine as it is to-day is a tremendous improvement on the stuff they had to put up with during the last war. "In fact," one said, "the only difference that I can see between the two is that in margarine the ingot is from a different mould and the fracture is slightly more brittle. And when you consider that supplies are good and think of the price per ton—well, I ask you, butter is hardly worth worrying about!"

* * *

In the same letter, Mr. Shepherd also quotes a story of a very junior clerk who stood gazing out of the window at the glorious sunshine (this must be a pre-war tale). As the director walked into the room, his young assistant innocently remarked, "We are going to have a wonderful day, sir." "Good Lord," gasped the great man; "*we* indeed! How long have you been a partner in this firm?"

* * *

The Vice-President of the Section, Mr. George Hall, also records a suggestion that in the spring, when the weather and black-out conditions improve, the members might meet for a cup of tea and an informal chat. Cup of tea, indeed! As "Marksman" reads this choice suggestion a band of urchins in the street are bellowing "Roll out the barrel! Let's have a barrel of fun!" That advice seems strangely appropriate for orthodox foundrymen.

* * *

The current issue of "Metal Progress" contains some amusing howlers which purport to be taken from definitions asked in a general knowledge examination. They included the following:—

A conundrum is a rare metal from the mines in the Acrostic region.

Barium is what they do to dead people.

An electrolyte is a thing which, when it is dark, you turn on and it gets bright.

Chlorine is a dancer in a night club.

* * *

An English schoolgirl just nine years old was reading out at the breakfast table a letter she had received from a French friend not much older than herself. In it, petite Marcelle wrote: "I wish you a very happy New Year, with peace and victory to our two dear countries, who are now like sisters." "Hum, Hum," was all the youngster had to say to that, but a moment later she had to be reprimanded for jabbing her fork repeatedly into the sausage on her plate. "Well," she explained, "I'm only thinking that if I were a big man that's what I'd do to old Hitler!"

"MARKSMAN."

Effect of Elevated Temperatures on Steel Sand Mixtures

A REPORT ON PROGRESS OF RESEARCH

By H. L. YORK (Research Fellow, Cornell University)

The American Foundrymen's Association, having well-developed sand testing and control at room temperatures, realised the importance of continuing the work to include tests at elevated temperatures. This has been initiated under the auspices of the Committee on Foundry Sand Research by the staff of Cornell University. The investigator in charge was under the immediate supervision of Dr. H. Ries. The practical value of the research, which is described in the present Report of Progress (read before the A.F.A.'s 43rd annual convention at Cincinnati) has been stressed by the chairman of the Committee, Mr. D. L. Parker, of the General Electric Company, and his statement appears as an appendix to Mr. York's Report, which is here reproduced in slightly abridged form.

The programme of sand research was formulated by Sub-Committee 6b7 on Steel Sands, of the Foundry Sand Research Committee of the American Foundrymen's Association. The committee directed that certain sand mixtures be tested, specified the sands and binders to be used, the proportions in which they were to be mixed, and the exact method of test procedure. The object of the tests was to determine the behaviour of certain sand mixtures at elevated temperatures, and to acquire information which could be used as a guide in future investigations.

Sand Mixtures

The committee originally specified that a number of sand mixtures be tested, including brass sands, grey-iron sands and steel sands. After making preliminary tests of some of these mixtures, it was found that the programme was too comprehensive. It was then decided to concentrate on certain steel sand mixtures.

The mixtures finally selected included four silica sands bonded with fireclay, the same four sands bonded with bentonite, and one natural moulding sand, the bond of which was reduced by adding sand No. 5. Table I shows the character of the sands selected.

Preparation of Specimens

Mixtures were made in a No. 0 Simpson muller, and the standard A.F.A. 2-in. test specimen baked at 110 deg. C. for 2½ hrs. was used in making all the tests. Baked specimens were kept stored over calcium chloride in a large dessicator. In so far as it was possible, the specimens were prepared and tests made in accordance with the methods prescribed in the A.F.A. test code as published in "Standards and Tentative Standards for Testing and Grading Foundry Sands and Clays."

All mixtures were tested for green and dry permeability and green and dry compression strength.

A gas-fired furnace designed and constructed in the laboratory at Cornell was used in making the tests. The products of combustion pass from the combustion chamber through a flue into the testing chamber, where they move upward around an alundum core in which the specimen to be tested is placed. The furnace heats very uniformly and is easily controlled.

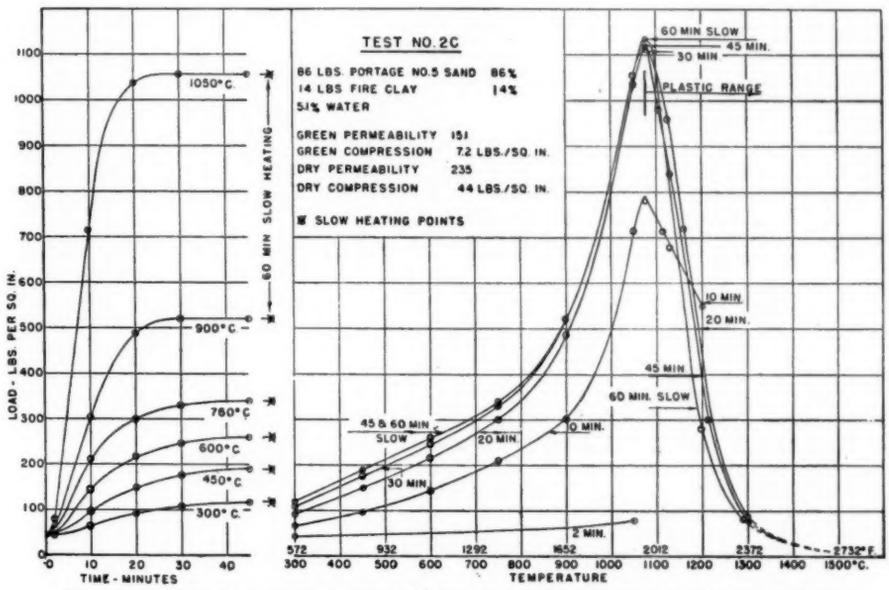


FIG. 1.—CURVES TYPICAL OF A SAND MIXTURE NOT AFFECTED BY TEMPERATURE SHOCK.

The curves at left show the rate of baking at different temperatures and the corresponding compression strength. Absence of shock effect is shown by identical strengths upon heating slowly as compared with sudden exposure to the test temperature. The curves at the right show the strength attained by the sand specimens after exposure at a certain temperature for various time intervals. The bond partially fuses to plastic between 1,075 and 1,300 deg. C. The bond acquires a glassy appearance at 1,300 deg. C.

Compression Tests

Compression tests were made to determine the strength of the mixtures at various temperatures. Two types of tests were carried out: (1) slow heating tests, and (2) shock tests.

Slow Heating Tests

The true compression strength of the sand mixtures at various temperatures was determined by testing specimens which had been heated at a rate of 3 deg. C. per min. The specimens, after having been heated to the desired temperature, were left in the furnace for 35 min. at that temperature before testing. It was found necessary to conduct tests in this manner in order that the specimens would be baked* uniformly throughout.

Shock Tests

The effect of "heat shock" on the sand mixtures was determined by placing specimens in the furnace which had been previously heated to the desired temperature. The specimens were then left in the furnace for time intervals varying from two minutes to that necessary for the development of a constant strength. Each of these tests represents conditions that exist in a mould at the time of casting. The sand on the face of a mould is subjected to heat shock; that back from the face is heated more slowly.

Temperature Intervals of Tests

Tests were made at intervals of 150 deg. C., starting at 300 deg. C. Additional tests were made to determine the true form of the curves in the vicinity of maximum strength and in the plastic range. All tests were made in duplicate, and in case the results did not check within 10 per cent., the test was repeated until

TABLE I.—*Base Materials.*

Sand no.	1	2	3	4	6
Type	Rounded.	Angular.	Sub-angular.	Sub-angular.	Rounded to sub-angular.
Screen analysis :—					
On 6	0·00	0·00	0·00	0·00	0·00
12	0·00	0·00	0·08	0·00	3·20
20	0·04	3·12	1·24	0·02	7·20
30	5·68	12·82	9·86	0·68	10·80
40	50·13	32·58	25·00	2·98	13·60
50	31·73	25·40	31·38	11·20	23·80
70	7·23	13·02	19·68	27·62	14·80
100	3·35	8·32	9·90	37·40	5·60
140	1·56	3·54	2·18	13·22	0·80
200	0·55	0·86	0·56	4·84	0·50
270	0·22	0·08	0·06	0·88	0·30
Pan	0·26	0·26	0·04	0·30	0·40
A.F.A. fineness no.	38·1	41·0	42·13	69·0	35·0
Clay	—	—	—	—	19·0

Other materials (binders, etc.): (1) bentonite, (2) fireclay.

* The term baking refers to the exposure of the sand to temperatures above 110 deg. C. American Foundrymen's Association, "Standard and Tentative Standards for Testing and Grading of Foundry Sands and Clays," 4th Edition, 1938, p. 161.

checks were obtained. Some tests were repeated as many as six times.

Properties of Sand Mixtures at Elevated Temperatures

The influence of heat on the sand mixtures tested is best shown by a discussion of the data presented in graphic form. These data show that some mixtures are affected by shock while others are not. Curves of a sand mixture that is not affected by shock will be discussed first, and test No. 2C (Fig. 1) illustrates the behaviour of such a sand mixture.

The curves at the left of the figure show the relationship between strength and time at various temperatures for specimens which were subjected to shock. The slope of the curves indicates the rate of rise in strength as the specimen is progressively heated to the centre. When the specimen is baked uniformly throughout, the strength becomes constant.

The time required for a specimen to develop its maximum strength depends upon the temperature to which the specimen is exposed. This time varies from 35 min. at 300 deg. C. to 10 min. at 1,050 deg. C. If the completely baked specimen which had been subjected to shock shows the same strength as the one which was slowly heated to the test temperature, the sand was unaffected by shock. The points not connected to the curves and designated as "slow heating" represent the strength of the sand when heated, at the rate of 3 deg. C. per min. to the test temperature.

The curves at the right, up to the point indicating the maximum sand strength, were derived from the curves on the left. The points for higher temperatures were obtained from test data. These curves show that the sand gains strength with a rise of temperature until the maximum strength is reached. If the temperature be raised beyond that corresponding to maximum strength, the strength drops off rapidly to about 50 lbs. per sq. in. At still higher temperatures, the strength drops slowly until it reaches zero at the temperature at which the specimen slumps under its own weight.

The decrease in strength at temperatures above the temperature of maximum strength is due to progressive fusion of the bond. The bond becomes plastic, and deformation under pressure is pronounced. The temperature range in which the sand specimens exhibit properties of plasticity under pressure may be called the "plastic range." The plastic range may be divided into two stages. In the first stage, the bond becomes plastic, but shows no visible signs of fusion. This stage of the plastic deformation is illustrated by the descending portion of the curve between the temperature of maximum strength and the temperature at which the strength begins to drop very slowly. The behaviour of the specimen in this temperature range indicates that the bond is partially fused. In the second stage, which is shown by the lower part of the curve, the bond is completely fused, and in this condition it behaves as a viscous liquid.

It should be observed that the 60-min. slow heating, the 45-min. shock and the 30-min. shock-test curves at the right are practically identical. Since one of these curves represents the behaviour of the sand mixture under slow heating and the other two under conditions of temperature shock, it should be obvious that the sand was not affected by shock. The spread of these curves, beyond the point of maximum strength, is due to the progressive fusion of the bond with time. The specimens which were heated slowly developed a strength below that of the specimens exposed to shock heating because the additional time allowed for the slow heating permitted fusion of the bond to progress to an extent not obtainable in the shorter time allowed for shock tests.

Another sand mixture which was not affected by temperature shock is shown in Fig. 2.

Curves of a sand mixture that is affected by temperature shock will now be discussed. The curves of test No. 4C (Fig. 3) are typical of a sand mixture affected by temperature shock. The effect of temperature shock, on sand mixtures susceptible to it, is to produce cracks in the specimen. The effect of cracking is to reduce the strength of the specimens. The compression strength for the shock-test curve in Fig. 3 could not be determined at temperatures above 600 deg. C. because of the shattering of the specimens when exposed suddenly to the test temperatures above that point.

It should be observed that the shock-test curve at the left in Fig. 3, showing the strength-time relationship at 600 deg. C., indicates a strength of 115 lbs. per sq. in. for the specimens heated 35 min., and a strength of 144 lbs. per sq. in. for the specimens heated slowly from room temperature to 600 deg. C. and held at that temperature for 35 min. The difference in strength is due to the formation of small cracks in the specimens which were subjected to shock-tests at the temperature of 600 deg. C.

If the sand mixture represented in Fig. 3 had not been susceptible to temperature shock, the 35-min. shock-test curve would have been identical with the 35-min. slow-heat curve.

It is possible, in some cases, to obtain check results on compression strengths even though cracking from temperature shock occurs. The curves at the right of Fig. 4 show that slow heating tests are necessary to determine the true sand strength. The points obtained from the shock tests produce smooth curves which conform in general shape to the curves to be expected for a low-strength sand mixture not affected by temperature shock. It is only by comparison with the strengths developed by slow heating that it is possible to determine the effects of temperature shock in this sand mixture. The specimens developed very small

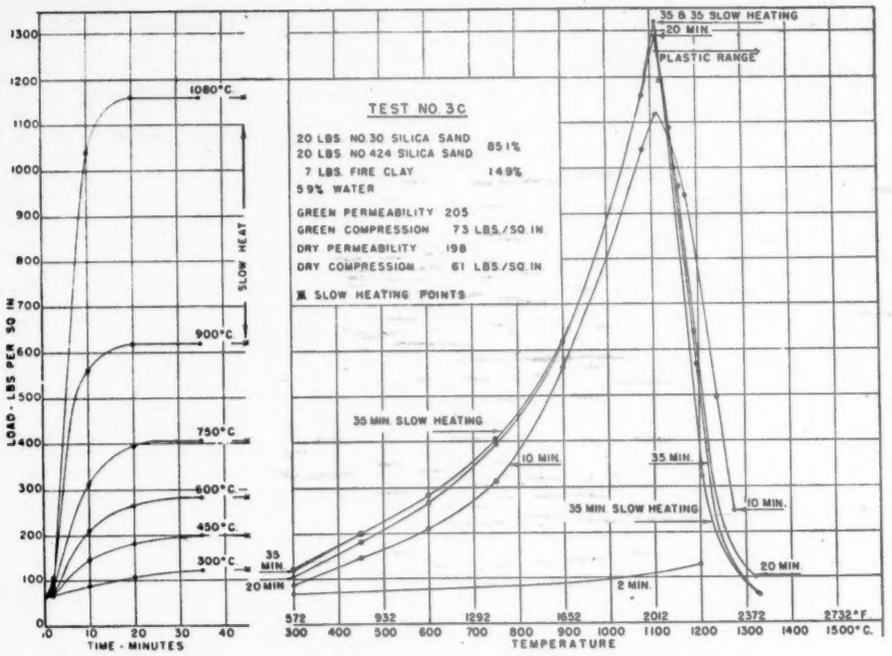


FIG. 2.—A SAND MIXTURE NOT AFFECTED BY TEMPERATURE SHOCK.

The descending portions of the curves at the right show that specimens undergo plastic fusion in the plastic range and for a given temperature the strength is dependent upon the time of exposure.

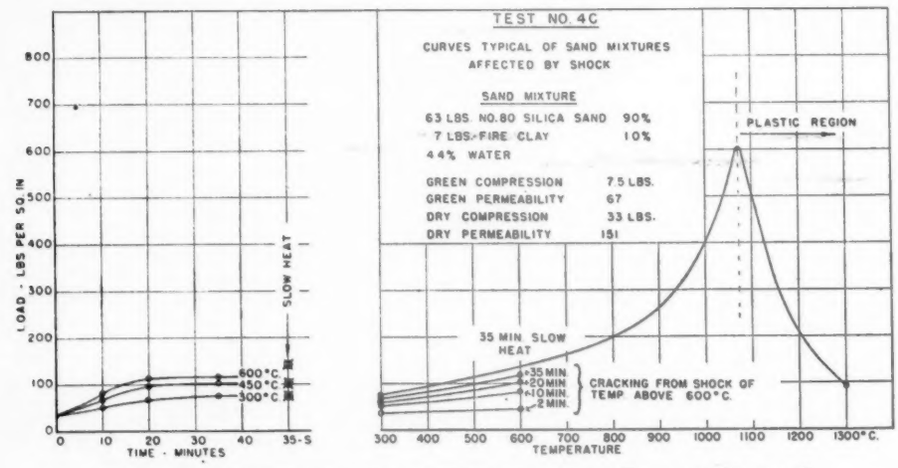


FIG. 3.—THIS MIXTURE DID NOT WITHSTAND THE SHOCK TESTS AT 600 DEG. C.

The true strength as shown by slow heating is 600 lbs. per sq. in.

cracks upon exposure to temperatures above 450 deg. C.

Removing a specimen from the hot furnace for the purpose of examination for cracking is not desirable, because sudden cooling may produce cracks which were not present when the specimen was in the furnace.

It was observed that some sand mixtures cracked when heated at a rate of 3 deg. C. per min. If cracking occurs on slow heating, the rate of heating should be reduced until the specimens are no longer affected. The erratic behaviour of a sand which cracked on slow heating is shown in Fig. 5. The scattered points, through which the curve was not drawn, were obtained by slow heating. This sand mixture should develop its maximum strength at about 1,000 deg. C., but failed to do so because of cracking at a low temperature (about 600 deg. C.).

Character of Failure of Sand Specimens Under Load

If a sand is not affected by temperature shock, and if it is tested at a temperature below that of maximum strength, the specimen will fail on shear planes with a conical-shaped fracture. If the fracture is not conical, the specimen either cracked from temperature shock, was defective, or was eccentrically loaded.

At temperatures above that corresponding to maximum strength, the sand specimens mash or deform permanently under load. The bond undergoes progressive fusion in this temperature range and the specimens become somewhat plastic. They do not collapse, but become barrel-shaped and crack in circumferential tension.

Sands Bonded with Bentonite

It was observed that the bentonite-bonded sands which were tested disintegrated on cooling from any temperature between 900 and 1,200 deg. C.

If the bentonite-bonded sands were heated above 1,200 deg. C., they did not disintegrate on cooling, but became very strong. The bond of such specimens appeared glassy after cooling.

In a bentonite-bonded specimen which was heated at a rate of 3 deg. C. per min. to 1,540 deg. C. and then cooled to room temperature, the bond was fused, with the result that the sample deformed permanently under its own weight. Deformation did not occur until several minutes after the specimen had reached 1,540 deg. C. On cooling, the specimen, instead of disintegrating, developed a strength of approximately 600 lbs. per sq. in.

Sands Bonded with Fireclay

The sands bonded with fireclay did not disintegrate on cooling from any test temperature. When heated to temperatures between 900 and 1,200 deg. C., the specimens on cooling showed a decreasing strength with increasing test temperature. When heated to 1,300 deg. C., the specimens on cooling were so fragile that it was difficult to handle them without breaking. If heated above 1,300 deg. C., the strength after cooling increased with the temperature of heating. One specimen was heated to 1,200 deg. C. and was stronger after cooling than the specimen which was heated to 1,300 deg. C.

Sand Deformation

The total compression deformation of the sand specimens was measured at the maximum load for each temperature. Curves showing the relationship between temperature and deformation are given in Fig. 6. All the sand mixtures tested behaved in a similar manner, in that the deformation increased very slowly up to the temperature at which the bond began to fuse. As fusing of the bond progressed, the deformation increased very rapidly.

Expansion-Contraction Tests

The results of expansion-contraction tests are not included in this report, for the reason that methods heretofore commonly used proved to be unsatisfactory at high temperatures. New apparatus has been constructed, and tests are now being made.

Summary of Results and Conclusions

It is not safe to draw sweeping and definite conclusions from the tests thus far made, but it appears that the following can be drawn:—

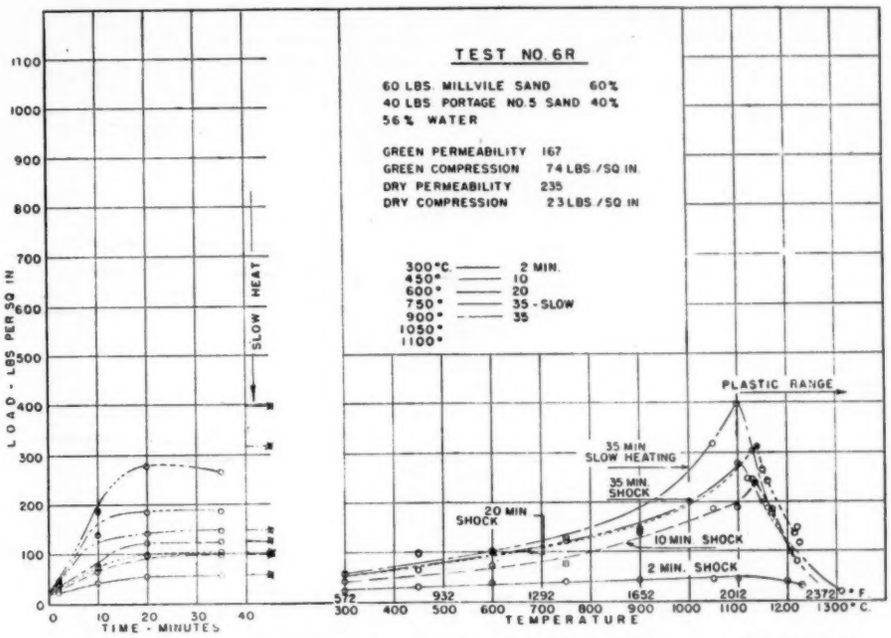


FIG. 4.—THIS MIXTURE CONTAINS 11.4 PER CENT. A.F.A. CLAY, WHICH IS AN INGREDIENT OF THE MILLVILLE GRAVEL.

All specimens cracked when exposed to a shock test at approximately 450 deg. C., and consequently show a lower strength than was obtained by slow heating.

Comparison of Tests

If the list of mixtures tested be examined, it will be observed that four sands were used and that each was mixed with bentonite and with fireclay bond. It was directed that in each case the mixture be made up to show 7½ lbs. green strength. In Table II these mixtures are arranged in pairs, and the heading of each column shows what it represents.

(1) Neither the bentonite nor the fireclay-bonded sands as a group are unaffected by heat shock.

(2) Some sand mixtures were sensitive to heat shock, and specimens made of these mixtures cracked at a comparatively low temperature. Other mixtures were unaffected by heat shock and developed the same strength under shock test conditions as when heated slowly.

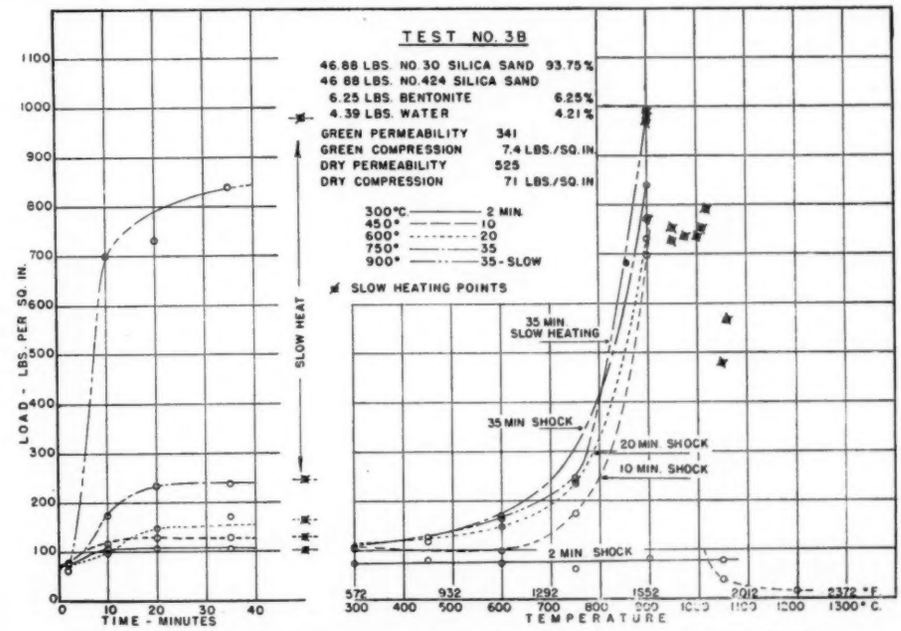


FIG. 5.—SAND MIXTURE AFFECTED BY SHOCK WHEN HEATED AT 3 DEG. C. PER MIN.

The specimen cracked at 600 deg. C., which prevented the development of the normal strength at higher temperatures. The scattering of the points at the right was caused by the cracking of the specimens, thus making it impossible to construct the descending part of the curve.

(3) The strength of the sand mixtures tested increased with temperature up to the temperature at which the bond began to fuse. At higher temperatures, the strength decreased rapidly and approached zero at the temperature of complete fusion of the bond.

(4) The fireclay-bonded sands in every case reached their maximum strength on slow heating at a higher temperature than the corresponding bentonite-bonded sands. This difference averaged 75 deg. C.

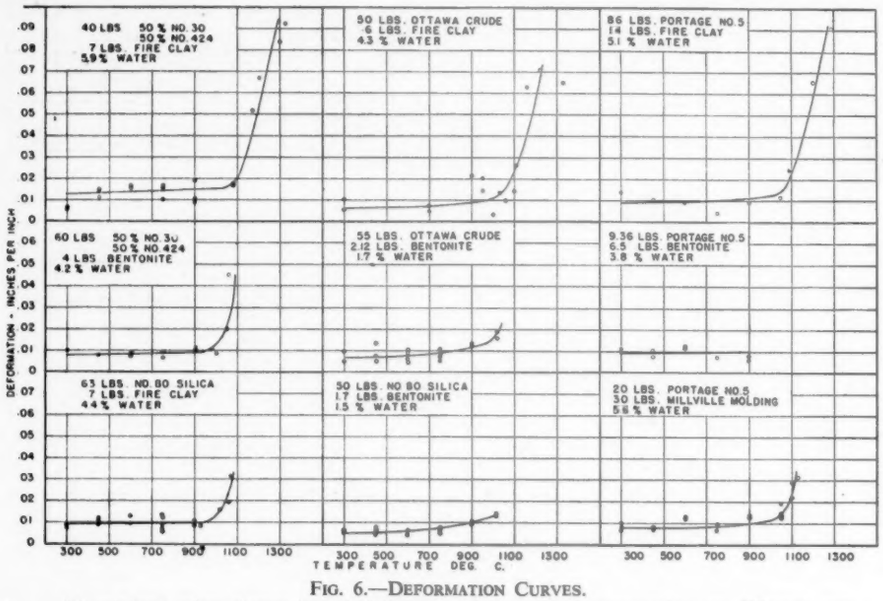

40 LBS 50 % NO 30 50 % NO 424
7 LBS. FIRE CLAY
5.9 % WATER
50 LBS. OTTAWA CRUDE
6 LBS. FIRE CLAY
4.3 % WATER
86 LBS. PORTAGE NO.5
14 LBS. FIRE CLAY
5.1 % WATER
60 LBS 50 % NO 30 50 % NO 424
4 LBS. BENTONITE
4.2 % WATER
55 LBS. OTTAWA CRUDE
2.12 LBS. BENTONITE
1.7 % WATER
9.36 LBS. PORTAGE NO.5
6.5 LBS. BENTONITE
3.8 % WATER
63 LBS. NO. 80 SILICA
7 LBS. FIRE CLAY
4.4 % WATER
50 LBS. NO 80 SILICA
1.7 LBS. BENTONITE
1.5 % WATER
20 LBS. PORTAGE NO.5
30 LBS. MILLVILLE MOLDING
5.6 % WATER
DEFORMATION - INCHES PER INCH
TEMPERATURE DEG. C.

FIG. 6.—DEFORMATION CURVES.

All mixtures when slowly heated deformed slightly under compression at different temperatures until the maximum strength was reached; above this, deformation increased rapidly in the plastic zone.

(5) (*a*) The bentonite-bonded sands disintegrated on cooling from any temperature between 900 and 1,200 deg. C. (*b*) The sands bonded with fireclay became very fragile, but did not disintegrate on cooling from any test temperature. (*c*) Sand specimens bonded with either fireclay or bentonite developed a high strength on being cooled from the temperature at which the bond became completely fused.

(6) The total deformation of the specimens at the maximum load did not increase appreciably with temperature until the bond began to fuse.

(7) The composition of the mixtures did not permit the drawing of any conclusions regarding the effect of fineness of sand, amount of moisture, and amount of bond on the hot strength. Tests are now under way to obtain this information.

(8) The hot strength at a given temperature in the plastic zone was always higher for the fireclay-bonded sands than for those bonded with bentonite.

TABLE II.—*Properties of Sand Mixtures Related to Elevated Temperatures.*

Fig. no.	Mix no.	Sand used.	Aver. fineness.	Per cent. sand.	Bond.*	Per cent. bond.	Per cent. water.	Shock limit. Deg. C.	Max. str. lbs.	Temp. Deg. C.	Final str. lbs.	Temp. Deg. C.	Dry comp. str. lbs.
5	4B	No. 80	69·0	96·7	B	3·3	1·5	600	400	1,000	25	1,180	9
4	4C	No. 80	69·0	90·0	F.C.	10·0	4·4	600	600	1,075	100	1,300	33
—	1B	Ottawa crude	38·1	96·3	B	3·7	1·7	750	300	1,000	15	1,200	10
—	1C	Ottawa crude	38·1	89·3	F.C.	10·7	4·3	700	875	1,110	60	1,330	33
—	3B	30–424	42·13	93·75	B	6·25	4·21	600	1,080	900	cracked		71
2	3C	30–424	42·13	85·1	F.C.	14·9	5·9	none	1,300	1,110†	70	1,325	61
—	2B	Portage No. 5	41·0	93·6	B	6·4	3·8	450	1,100	975	25	1,220	100
1	2C	Portage No. 5	41·0	86·0	F.C.	14·0	5·1	none	1,100	1,075	80	1,300	44

* B = Bentonite. F. C. = Fire Clay. † Specimens mashed.

APPENDIX

BY D. L. PARKER.*

To those engaged in the manufacture of steel castings, the foregoing Report should be of extreme interest to both the practical and technical foundrymen. It opens an entirely new field of thought pertaining to sand mixtures and properties. The "Hot Strength Committee" feels that the information contained in this Report will be of assistance in the development of better methods of compounding sand mixtures to meet the actual conditions that develop in the casting of molten metal.

A practical example comes to mind that occurred during the preparation of this statement which, it is thought, is well to summarise, in that hot strength properties, if available, would aid greatly in helping to solve the problem.

Sand mixture A, composed of silica sand, silica flour, bentonite and core oil, is used as a facing on turbine castings from 5,000 to 40,000 lbs. in finished weight; in addition it is also used on certain other work, about 1½ in. average thickness with the castings having numerous T and L sections. It is desired to compound a mixture B having the same properties with the exception that it will be more collapsible, thus facilitating the production of these castings with a minimum of "hot tears." In order to accomplish this, the bentonite content was materially reduced and some core oil taken out, a dry binder was added together with a small amount of cereal for green strength. The following physical properties were obtained:—

	Mix A.	Mix B.
Moisture (per cent.) ..	8·0	8·0
Flowability	77·0	82·0
Green permeability ..	40·0	38·0
Dry permeability ..	61·0	58·0
Green comp. strength (lbs. per sq. in.) ..	10·9	8·2
Dry tensile strength (lbs. per sq. in.) ..	125·0	120·0

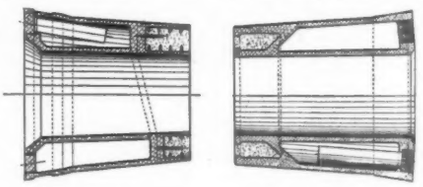
One can readily see that, with the exception of green compression and flowability, there is little to be gained in comparing the results, yet from practical experience it is known that mixture B should be much more collapsible. It is a personal contention that if these two facings were subjected to hot-strength tests involving expansion-contraction, compression and collapsibility, one would know exactly what to expect in regard to hot-tearing.

Summarising the progress to date of the "Hot Strength Research" being carried on at Cornell University, it is safe to say that the first positive results are now being obtained after many months of concentrated activity involving the development of a furnace and testing technique. With the programmes as outlined at two Committee meetings, held prior to the 1939 Cincinnati A.F.A. Convention, there should be definite and comprehensive data available for dissemination to the industry in the very near future pertaining to hot strength properties of steel foundry sand mixtures.

* Chairman, Sub-Committee 6b7, Hot Strength Research on Steel Foundry Sands, A.F.A. Committee on Foundry Sand Research.

Beaton Tuyeres

We illustrate sections of two Beaton tuyeres which are manufactured by Ashmore, Benson, Pease & Company, Limited, of Stockton-on-Tees. The nose is of a special highly refractory



material, which makes the tuyeres particularly suitable for permanent or occasional use in furnaces where through soft coke or other causes trouble is experienced. Beaton tuyeres can be made to any specification.

"Corronizing"

"Corronizing" is the application of a metallic pore-free coating called Corronite which, it is claimed, has shown ability under standard salt spray and other corrosion tests to resist corrosion far beyond that previously available in ordinary steels. The cost of producing the coating is said to be comparable with that of conventional coatings. The process of "corronizing" is simple. Nickel is electro-plated in any desired thickness on metal, upon which either zinc or tin is plated. The coatings are then fused through heat treatment. It is claimed that the bond of the Corronite to the steel is so firm and the ductility of the coating so high that severe types of fabrication do not impair the protective value of the coating. The process was originally developed by Standard Steel Spring, from search for a method of protecting oil well sucker rods from the exceptionally severe corrosion of hydrogen sulphide and salt water present in some oil wells.

Monolithic Linings for Cupolas

HINTS FOR SUCCESSFUL OPERATION

The December meeting of the West Riding of Yorkshire Branch of the Institute of British Foundrymen, held at Bradford Technical College, had been reserved for discussion of any general foundry problems members might care to raise. It was, however, thought desirable to give further opportunity for exchange of opinions on the subject of cupola linings, as raised by Mr. F. Oldershaw, of Leeds, in his address at the November meeting on "The Practical Application of Monolithic Linings" (printed in our issue of December 9). Mr. S. Carter presided.

Constructional Details

MR. OLDERSHAW opened the renewed discussion himself by some further observations arising out of the previous month's diverse views on firebrick *versus* monolithic linings. It was, he agreed, a difficult matter for a foundryman to decide which of the two was the better in service and cost for his own particular plant and purposes. There were so many factors to be taken into consideration. Chief of these were the quality of materials, treatment of materials, and the amount of iron melted at each blow. Provided that the quality of material was equal alike in refractoriness, stability and strength, and both types were treated alike, then the difference in wear and tear would be practically nil provided the same amount of metal was melted in each furnace. For a good many years he used firebricks and ganister both for lining and patching the cupolas, and obtained what was thought were fairly good results. A lining lasting about twelve months was considered satisfactory. His method of lining a cupola 18 in. thick was to start next to the shell with a 4½-in. circular stretcher, put in front of it a 2-in. brick and in front of this a 9-in. header, then finishing off with another 2-in. brick in front of that. This was continued up to the top of the slag notch. Then followed on top of this two rows of 4½-in. circular stretchers and then a 9-in. circular header in front, which was continued to the melting zone. From this point a row of 4½-in. circular stretchers was left out making the lining 13½ in. thick. This was carried up to the iron blocks 4 ft. 6 in. above the melting zone, iron blocks being continued to the charging door. Upon each completed circle of firebricks a grouting of fireclay was spread, filling all joints between sides and ends of bricks. This fireclay prevented any slag, iron or foreign matter penetrating between the bricks, until sufficient glaze and fusion were obtained in the ends of the bricks to exclude all possibility of either slag or metal getting between the bricks.

After each blow the well of the furnace required as much material for repairs, both bricks and ganister, as any other part of the furnace. The 2-in. bricks placed in front were usually melted away and had to be replaced, sometimes requiring as many as 120 bricks to restore the well to its original size. This was attributed to the corrosive action of the slag. A few years ago his firm was offered a plastic material for lining and patching. A few bags of this material were sent for a trial. As there was not sufficient to repair the cupola more than once from well to melting zone it was decided to use part of it for making up the slaghole and repairing the well of the furnace. This was done and after a blow of 50 tons the well needed very little repair. A further trial was carried out with the remainder of the plastic in another cupola of exactly the same dimensions in the well and melting capacity, but instead of patching the well with all plastic, 2-in. firebricks and plastic were used, the firebricks being placed at intervals of about 9 in., held in position with plastic. On examination after a blow of 50 tons, the firebricks had entirely disappeared, whilst the parts covered by plastic showed very little wear.

A Comparative Test

After this experience it was decided to line one cupola with plastic material from hearth to iron blocks, and the other cupola with firebricks as usual; and as these cupolas were next to each other and were blown on alternate days from the same blower, delivering the same quantity and quality of metal, a more exhaustive test could be obtained. This was done, and it was found that the brick-lined cupola gave the same service as usual—namely 12 months' wear—and then needed relining, the brickwork being almost burned back to the 4½ in. brick next to the shell. On the other hand, the plastic-lined cupola, at the end of twelve months, showed very little wear. The diameter of the cupola had increased only from 42 to 45 in. in the well, diameter of tuyeres 47 in.; twelve inches above tuyeres 46 in.; above melting zone 44 in. The original diameter was 42 in. parallel. The brick-lined cupola diameter was 42 in. from well to melting zone; 51 in. from melting zone to iron blocks, a distance of 4 ft. 6 in. After this experience it was decided to ram this cupola with plastic, and also two others. The difference in building costs between a monolithic and a firebrick-lined furnace was slight—a matter of 22s. 6d., this being due to the longer time taken to ram the lining.

In conclusion, Mr. Oldershaw expressed thanks to Mr. J. Wood, Wakefield, in charge of furnaces, for data he had obtained to assist in the compilation of the speaker's commentary.

Drying Times

In answer to Mr. H. Forrest (Bradford), MR. OLDERSHAW said he used a pneumatic ram of ordinary type with a round flat end and rubber-shod foot.

In reply to the President (Mr. Carter), who asked for an approximate time for lining and ramming, say, 6 in. thick, MR. OLDERSHAW reminded the meeting of his original statements, in November, that the time depended on drying the lining. The longer time that could be allowed for drying the better service it would give. If it must be rushed, they might achieve success, but the drying was a very important factor and was better not to hurry if it could be avoided. He should say it would be possible to get a 6-in. lining dry in about three days.

Answering a member, MR. OLDERSHAW said a big drying fire was neither necessary nor desirable. A large cupola would hold a good-sized fire without it licking the sides with fierce flame before expelling the steam. If steam were driven to the back it was liable to cause the lining to rupture.

In reply to a question as to the desirability of venting, which was asked by MR. WORCESTER, MR. OLDERSHAW said, using a ¼-in. vent. wire, vents would be sufficiently large to free the lining from steam, and would help considerably in quick drying. The lining must not be cooled until thoroughly dry, and the steam must not be expelled too quickly.

MR. S. W. WISE (Hon. Secretary, Bradford) asked whether, if Mr. Oldershaw were starting a new foundry, he would put in brick or monolithic lining to his cupola.

MR. OLDERSHAW said, in the light of his experience now, he would start with monolithic lining.

MR. WISE said that, in his experience of brick linings, he found them very satisfactory; they consumed very little ganister. He endorsed Mr. Oldershaw's statement as to the need for care of lining.

MR. OLDERSHAW stated that if the monolithic lining failed, it did so as a body—not in areas as did a lining of individual bricks. Once a monolithic lining has been properly vitrified, there was a single area. It was preferable to have two thin linings, one inside the other and both vitrified, than one thick lining which may have only a vitrified part in it.

Withstanding Soda Ash

MR. OLDERSHAW, replying to a question on the effect of sodium carbonate on the monolithic lining, said this plastic material was a good refractory and would stand up to sodium carbonate and slag mixed, but he had not himself had occasion to use sodium carbonate in connection with these linings.

Another member felt that, with a 5 in. lining, there would be thermal losses through increased heat conductivity, thus impairing efficiency.

Material or Method?

MR. H. A. MACCOLL, B.SC., said one could not see any advantage merely from the method of lining. Suppose one took a sample of raw fireclay mixture similar to that of bricks, but not made into bricks, and rammed that mixture as a lining. What was likely to be the result as compared with the rammed plastic mixture?

MR. OLDERSHAW said that, personally, he would not think of so doing. A brick may contain extraneous material.

MR. MACCOLL said the problem could be posed conversely, and he asked what would be the result if it were lined with bricks of the plastic material used?

MR. OLDERSHAW replied that if he could get anybody to make some bricks of the material of a standard monolithic lining, it would be a most interesting and probably valuable experience to try them out in a foundry cupola. It was obvious that there were many good firebricks on the market, but even then there was still the trouble of joints—which was avoided in a rammed lining.

MR. MACCOLL said he asked that question to emphasise that it was not necessarily merely a question of material or of method. Actually he had had personal experience with the monolithic linings and could endorse all Mr. Oldershaw had said about their superiority in the respects he mentions; but the question still remains as to how much of the advantage is due to the material and how much to the method of application.

Method Predominant

MR. OLDERSHAW, agreeing, said two men might line a furnace with the same material, and one produce an excellent result and the other be dissatisfied, owing to different mixing and treatment and application. It is quite true that the method of application is an important point, quite apart from questions of material. It is important because a lined cupola had to work for a prolonged period, not a few weeks The cupola shell was not of itself a heavy cost as compared with the cost of weekly usage, and that fact should be given careful thought in deciding the nature of the lining.

A Recorded Failure

The BRANCH-PRESIDENT said he did not want to be discouraging or unfair, but as a matter of fact a rammed lining at his foundry was, he believed, about the worst lining ever installed, and the

cupola had to be stripped and relined with bricks. Admittedly, it was dried too quickly—only about two days being available for it; and that may perhaps account to some extent for the fact that it lasted only about six months, as against the normal twelve months of their usual brick linings.

MR. FORREST said the Chairman's view should not go entirely unchallenged. Was the lining at fault or the method of installation? He admitted it was very quickly dried, and that was a point Mr. Oldershaw had stressed should not occur with monolithic linings! In his (Mr. Forrest's) own case, whilst he would not say his experience with this material had been an outstanding success it was evident from the chairman's experience that it must be well dried.

Expansion Voids

In answer to a question by a member as to whether Mr. Oldershaw provided a void between the shell and the lining, later filling up this void with sand, the author said this was a matter of opinion but his own feeling was that it was not good practice. His linings were flush with the casing and he did not consider a void was necessary. There was a course of bricks inside the shell and the plastic material was rammed closely against the bricks. In a small cupola, with or without a course of bricks, the expansion would be less, and he did not consider a void was necessary.

MR. FORREST doubted if there was any expansion worth considering, but rather the reverse came into play.

MR. OLDERSHAW said that without being dogmatic, he thought there was a sort of double movement. The lining would contract on drying and on heating-up to a point it would expand followed by an arrest or even undergo contraction. Thus one movement would equalise the other.

In answer to another query as to drying time, MR. OLDERSHAW said members should not take too literally the period of a fortnight, because he (the speaker) had mentioned that time in his own case. If such time were available so much the better, but much depended on the nature of the material used. For quick drying five or six per cent. of moisture in the material should not be exceeded. With no means of checking, the moisture content may reach 10 per cent. Thus with reduced drying time, it was necessary to find means of working with the minimum possible moisture content.

Vote of Thanks

Hearty thanks to Mr. Oldershaw for his informative talks at both the November and December meetings were accorded on the motion of Mr. Drewitt, seconded by Mr. Turner. The latter congratulated Mr. Oldershaw on the unusual achievement of contributing a discourse which required two meetings to discuss it.

Dinner and Dance

The Hon. Secretary (Mr. S. W. Wise) reminded the meeting that at the opening of the session the members had approved the Council's decision to carry on the winter programme as near normally as possible under wartime conditions. The next gathering, according to that programme, was to be the annual dinner and dance, at the Great Northern Victoria Hotel, Bradford, on Saturday, January 13. Mr. Wise hoped that in spite of the curtailment of social activities as in many other spheres, the members of the Institute and their ladies would make a special point of supporting the dinner and show that the foundrymen could carry on in the face of any circumstances. They were to be complimented on their attendances at Branch meetings and the Council had every confidence they would be well supported in this effort.

Moulding a Balance-Wheel in Loam

BY "LOAM-BRICK."

Fig. 1 shows a plated balance-wheel which is a comparatively simple job to mould in loam. Not much tackle is required, as a bottom and top plate is all that is necessary, except, of course, for the strickles used to sweep up the mould. The dimensions of the casting are:—diameter 6 ft.; thickness of the plate 8 in., with an outside rim 14 in. deep, the weight of the casting being approximately 4½ tons.

Having placed the bottom plate on stands about a foot high, the spindle and strickle are set and the first course of bricks is laid on slurry. A space of about one inch separates each brick and these spaces are filled with ashes rammed in with the end of a flat file. The ashes are connected with the ends of four vent pipes, two or more inches in diameter. These vent pipes have been previously laid an equal distance apart on the plate, their outer ends coming flush with the outside of the brickwork. A rapid escape of air is thus ensured during pouring and the pipes also serve as an outlet for the steam during the time the mould is drying in the stove.

The strickle is lowered and set level ¼ in. from the face of the brickwork. Loam is then rubbed well on the face of the bricks, this operation giving the loam a firmer hold. This done, further loam is then applied for sweeping up and finishing purposes. The work on the

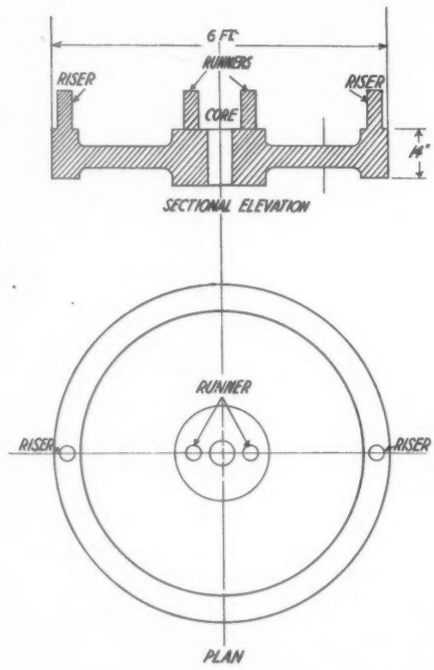


FIG. 1.—PLATED BALANCED-WHEEL.

top plate (Fig. 2) consists of practically the same operations as are carried out on the bottom part of the mould, but special attention is paid to venting. If this be carelessly carried out and the air and gases do not escape freely, they will push patches of loam from the face of the mould in their effort to escape and cause a waster.

Finishing and Casting

When dried the mould is given a thick coating of the best plumbago, which is sleeked to give a smooth finish. The bottom part of the mould is then lowered into a pit, the cope placed in position on it and the job rammed up and made ready for casting. Vents are led up from the ends of the pipes in the brickwork to floor level.

The casting is fed down the risers and through one gate on the boss, where ¼-in. rods are used for this purpose. It is important to remember to keep the feeding holes open as long as possible and to replenish with hot iron as necessity

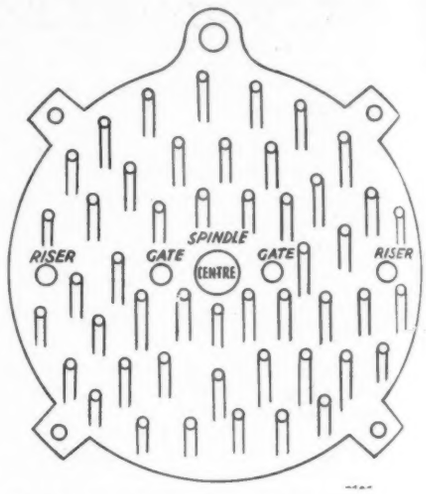


FIG. 2.—TOP PLATE READY FOR BRICKS TO BE LAID ON.

arises. It is advisable to leave the casting in the floor for a day or two for the purpose of slow cooling.

A loam with good bonding qualities is used as the roof of the mould will be subjected to the fierce heat of the metal immediately it enters the mould when there is danger from a weak loam "scabbing."

Mechanical Properties of Pure Silicon

In a Paper by A. B. KINZEL on "Pure Silicon," published in "Metals Technology," it is stated that, in order to get some idea of the mechanical properties of a cast bar of silicon made from the 99.84 per cent. material, a bar 0.254 in. sq., and something over 3 in. long, was prepared and tested as a beam with knife-edge supports on a 3-in. span and centre loading through a knife-edge. Deflection was measured directly by an indicating dial in 0.0001 in., and load measured by calibrated spring balances, using small lead shot. Using the standard formula for modulus of rupture of a rectangular beam, a value of 9,046 lbs. per sq. in. was obtained.

A modulus of elasticity of 15,490,000 lbs. per sq. in. resulted from application of the results in the standard formula, the actual breaking load of the specimen having been 35 lbs. and a deflection of 0.00108 in. corresponded to a load of 12 lbs. It is interesting that the load deflection plotted on cross-section paper of appropriate scale was a straight line. In this connection Templin's determination is of interest. Working on silicon with a purity of 99.41 per cent., taken by difference, he found Young's modulus to be about 16,350,000 lbs. per sq. in., based on the assumption that the value in compression is the same as in tension.

Magnetic Determination of Carbon*

H. K. WORK AND H. T. CLARK DESCRIBE A NEW INSTRUMENT CALLED THE "CARBANALYSER" FOR THE MAGNETIC DETERMINATION OF CARBON IN A STEEL BATH

The instrument for the rapid determination of carbon in steel, described in this Paper, was developed originally to facilitate the operation of the pilot-sized open-hearth furnace in the Jones & Laughlin Research and Development Laboratory. In this small furnace, with its shallow bath, the drop in carbon is accelerated, and a rapid, reliable test for carbon content is indispensable. This problem becomes rather acute when it is desired to finish heats at a carbon content higher than can be estimated with any degree of accuracy by the fracture test. Several independent methods for determining carbon were investigated, therefore, and it was found that a relatively simple magnetic device could be made to give reproducible results. A laboratory instrument was designed and set up for the use of the furnace operators, and a year or so ago, instruments were furnished to the plant open-hearth shops, and these have been in use since that time. As a matter of convenience, the instrument has been named the "Carbanalyser."

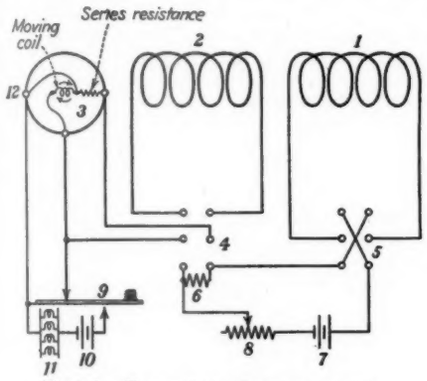


FIG. 1.—ELECTRICAL CIRCUIT OF THE CARBANALYSER.

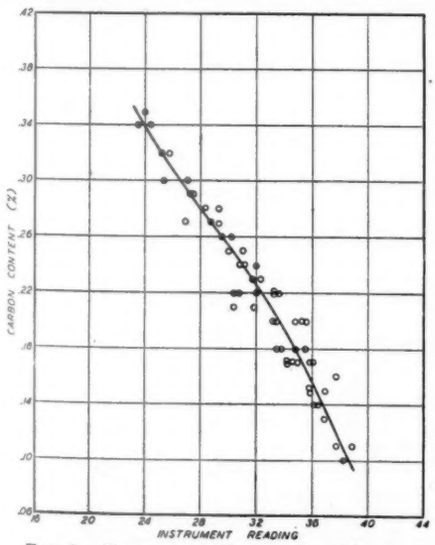


FIG. 3.—CALIBRATION CURVE OF A WORKS INSTRUMENT FOR THE LOW-CARBON RANGE.

The Carbanalyser may be considered as a special form of a permeameter, since it measures the change in flux in a bar produced by a known change in magnetising force. The change in the magnetising force ($\triangle H$) in this case is equal to $2H$ and the change in flux ($\triangle\phi$) is equal to 2ϕ, because the current in the magnetising coil is reversed. Therefore, if the cross-sectional area of the bar specimen is known, it is possible to calculate the permeability of the material, for the known value of H, by the application of the ordinary magnetic equations. The absolute values of the various quantities is of no interest in the present application; attention is paid solely to galvanometer deflections for a reversal of a given magnetising current, and these deflections are calibrated in terms of carbon content. The main objectives in this work have been: (1) Accuracy and reproducibility of results, (2) ease and speed of operation, and (3) simplicity and ruggedness of equipment.

Constructional Details

The details of the electrical circuit of the Carbanalyser are shown in Fig. 1. Coils 1 and 2 are the primary and secondary of a special induction coil. The current in the primary coil is supplied by battery 7, measured by meter 3, controlled by rheostat 8, and reversed by switch 5. The other double-pole, double-throw switch 4 is inserted in order that the same meter may be used in both the primary circuit (in parallel with the resistance 6) to measure the steady current, and in the secondary circuit as a ballistic instrument. The meter is a millivoltmeter and is designed to be short-circuited when not in use to prevent damage to the moving parts. This feature is used to advantage; the meter is short-circuited to protect it during the several reversals of current necessary to put the specimen in a standard state. The push-button switch 9 in its normal position short-circuits the meter through the shorting terminal 12. When pushed down for a reading, it releases the meter and lights, by means of battery 10, a group of flashlight bulbs 11 above the meter scale.

The millivoltmeter has a fairly rapid motion when used as a ballistic instrument, but has been used advisedly since it is satisfactory in a portable machine and may be read accurately by the aid of a small two-power reading glass mounted above the meter face. Likewise, it does not require levelling, holds its zero setting well, and is not affected by any normal works vibration. Other electrical parts, with the exception of the magnetic unit, are standard equipment.

The magnetic unit is shown in Fig. 2. The primary and secondary coils are wound on a hollow Bakelite form and held in position between the two heavy steel plates forming the sides of the yoke. The cylindrical specimen is thrust through the holes in the yoke and the coils, and is held in good magnetic contact with the yoke. This is a closed magnetic circuit, and stray magnetic fields in the vicinity cause no difficulty. The specimen may be inserted and withdrawn readily and will always be held in the same position with the same sidewise thrust against the soft-steel yoke. It has been amply demonstrated in repeated tests on the same specimen that the readings are reproducible, showing that the same magnetic coupling is attained each time the specimen is inserted. The size and shape of the specimen may be varied through relatively wide limits, although care must be taken that only specimens of the type for which the machine was calibrated are used. The Carbanalyser has been so designed that it is possible for readings to be taken on high-carbon and low-carbon samples alternately with no change in the instrument.

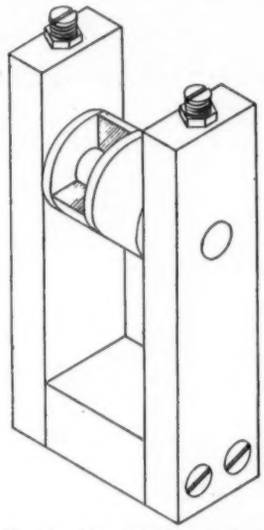


FIG. 2.—THE MAGNETIC UNIT.

Preparation of Specimen

The original experimental work included a study of the magnetic characteristics of specimens quenched under various conditions. It was found that a delayed quench was satisfactory for steels with carbon content below about 0.40 per cent., but that for contents higher than that the readings were not selective. A rapid quench was then tested for the range from 0.20 up to 1.50 per cent. carbon, and the results indicated that this method gave selective values from 0.35 per cent. carbon up to 1.50 per cent. or higher. The following procedure was adopted: A sample of metal was taken from the bath, killed with a measured quantity of aluminium and cast in a split mould. The speci-

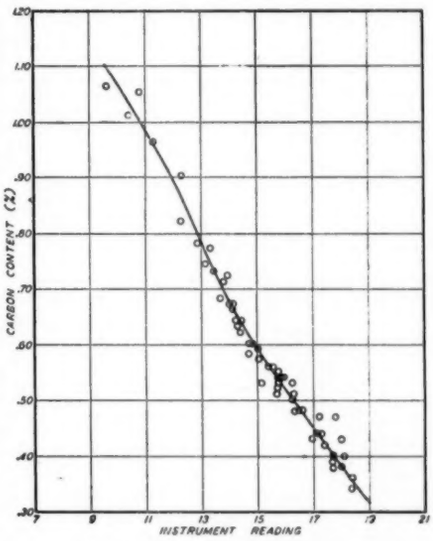


FIG. 4.—CALIBRATION CURVE OF A WORKS INSTRUMENT FOR THE HIGH-CARBON RANGE.

(*Concluded on page* 67.)

*From a Paper read before the American Institute of Mining and Metallurgical Engineers at Chicago.

Electric Steels

SOME METALLURGICAL FACTORS INFLUENCING THEIR DEVELOPMENT

The metallurgical factors influencing the development of electric steels were considered in a Paper on "Electrically Manufactured Steels," which was presented to the Institute of Electrical Engineers by MR. H. A. SIEVEKING, whose comments are given below.

There exists to-day a very large number of alloy steels, most of them developed during the last 25 years, some of which present manufacturing difficulties which can only be overcome in an electric furnace.

Three Main Problems

The problems to be met with in the manufacture of alloy steels may be summarised under three main headings, one or more of which will exist in any particular case:—

(i) Oxidation of some or all of the alloy metal. This applies particularly to chromium, vanadium, tungsten, and manganese.

(ii) The necessity for keeping out gaseous and removing solid impurities, particularly sulphur and phosphorus.

(iii) A rigid control of the analysis and temperature to within narrow limits in order that the ultimate structure of the steel may be correct. This is particularly important with regard to carbon, and the presence of some alloy elements makes it very difficult to obtain ingots in which the desired structure can be derived by heat-treatment.

It now becomes necessary, therefore, to see how far the electric furnace is able to reduce or overcome these difficulties.

High-Frequency Furnaces

Considering first the high-frequency furnace, this is not generally regarded as suitable for refining. Nevertheless, there is at least one large steelworks in Great Britain which uses a standard furnace of this type solely for this purpose, with excellent results. Moreover, with careful supervision it has been found that in spite of the very thin walls it is possible to get some 50 charges through before relining, corresponding to approximately one week's working.

On the other hand, when melting is in progress the danger of oxidation of chromium and vanadium is nil, and there is no source from which carbon can be picked up. Therefore this type of furnace is very suitable for producing chrome and vanadium steels, where the raw material is either known scrap or virgin material of known composition. To this must be added the advantage that there is continuous natural circulation in the bath caused by the electromagnetic forces set up by the energising coil—the degree of circulation is a function of the frequency.

These furnaces are also particularly suitable for intermittent operation, as they have a relatively low heat-storage capacity.

There are two general disadvantages to this type of furnace which should be pointed out. As yet it has not been built for capacities larger than 8 tons (5-6 tons in this country), and it is expensive in initial cost owing to the extensive electrical equipment needed; this latter defect is partly overcome by having two furnace bodies operating off the same electrical plant and so keeping it in continuous operation. Summarising, therefore, it may be said that these furnaces have as:—

Advantages.—(*a*) Absence of oxidising atmosphere. (*b*) No carbon pick-up. (*c*) Good natural mixing of bath. (*d*) Suitability for intermittent operation. (*e*) High temperature obtainable.

Disadvantages.—(*a*) Limited capacity. (*b*) Inability to refine easily, necessitating raw materials of known composition. (*c*) High capital cost.

Electric Arc Furnaces

Referring now to the arc furnace, this has been the prime cause of the development of electric steel, since an extremely accurate analysis can be obtained with it. In refining there are two distinct stages:—

(*a*) *Formation of black or oxidising slag.*—This is achieved by adding iron ore or mill scale, and lime, when manganese, silicon, carbon, and phosphorus are removed. Unfortunately during this stage there will be a tendency to remove the easily oxidised metals chromium and vanadium; skilled operatives can, however, recover a considerable proportion of the chromium present in the slag.

(*b*) *Formation of white or de-oxidising slag.*—This stage is peculiar to the electric process and consists in adding de-oxidising agents, such as ferro-silicon or ferro-manganese, with fluorspar, carbon, and lime. In this way all oxides are removed together with sulphur, and the bath is degassed. During this stage any alloying elements which may be required are added.

These furnaces are capable of large-scale production, while their initial cost is not excessive. Where certain flexibility in the carbon content is allowed the cheaper amorphous electrodes are used, but in the majority of cases graphite is preferred as with these there need be no carbon pick-up in the bath.

Circulation is confined to relatively small areas near the arc, and therefore hand rabbling or stirring has to be resorted to to keep the temperature of the bath even and the materials properly mixed. Further, the natural heat capacity of the furnace is high and it should therefore be kept in production for as long periods as possible.

Summarising, it may be said that these furnaces have the following advantages and disadvantages:—

Advantages.—(*a*) Ability to produce from relatively poor raw materials a steel having a rigid analysis. (*b*) Good capacity. (*c*) Reasonable cost. (*d*) High temperature obtainable.

Disadvantages.—(*a*) Tendency to oxidise out chromium and vanadium. (*b*) Indifferent mixing of the bath. (*c*) Unsuitability for intermittent operation. (*d*) Certain amount of carbon pick-up; small with graphite electrodes.

(*Continued from next column.*)

monthly wall calendar, each page carrying a picture illustrating "The Bountiful Earth," the whole assembly making a very interesting and charming collection.

The North Eastern Iron Refining Company, Limited, Stillington, Stockton-on-Tees—A daily tear-off wall calendar.

Thomas Robinson & Son, Limited, Rochdale—A monthly tear-off calendar suspended from a charming coloured picture of Malton, in Yorkshire.

Smith & Fawcett, Limited, Horton Works, Lidget Green, Bradford—A monthly wall calendar, each page of which has a picture of the works or its products.

Thomas Wilkinson & Company, Limited, Stockton Street, Middlesbrough—A daily tear-off calendar, carrying Shakespearean quotations, adapted for either hanging on the wall or standing on the desk.

Diaries and Calendars for 1940

In thanking the firms which so kindly sent us pocket diaries and calendars, we wish to reciprocate the good wishes which accompanied them. Diaries have been received from:—

British & Continental Traders, Limited, Lincoln House, High Holborn, London, W.C.1—A four-days-to-the-page pocket diary containing a wealth of data specially prepared for foundrymen.

Frodair Iron & Steel Company, Limited, of Fenchurch House, Fenchurch Street, E.C.3—A four-days-to-the-page pocket diary containing quite an amount of useful tabular matter.

J. Gray & Sons, Limited, of Victoria Street, London, S.W.1—The well-known and much appreciated vitreous enameller's diary.

G. A. Harvey & Company (London), Limited, Woolwich Road, London, S.E.7—A combination pocket-book and seven-days-to-the-page diary. Many useful technical data are included.

Staveley Coal & Iron Company, Limited, near Chesterfield—A four-days-to-the-page pocket diary with data about cast-iron pipes.

Stanton Ironworks Company, Limited, near Nottingham—A four-days-to-the-page diary containing well-chosen matter of special interest to foundrymen.

John G. Stein & Company, Limited, Bonnybridge, Scotland—A four-days-to-the-page diary containing an atlas, some data concerning refractories and a mass of tabular matter.

Stewarts and Lloyds, Limited, of London and elsewhere—A four-days-to-the-page pocket diary containing well-selected data about pig-iron, tubes, joints, and a number of metallurgical raw materials.

J. Stone & Company, Limited, Deptford, London, S.E.—A delightful waistcoat-pocket diary bound in sealskin.

Thomas & Clement, Limited, Llanelly, South Wales—A two-days-to-the-page pocket diary, an allowance which makes a really utilisable diary for recording day-to-day events in some little detail.

Calendars

Ashwell & Nesbit, Limited, Barkby Road, Leicester—A daily tear-off wall calendar carrying Shakespearean quotations surmounted by a particularly fine sketch of Essex Stairs by Joseph Pike.

Carborundum Company, Limited, Trafford Park, Manchester—A monthly tear-off wall calendar surmounted by the now famous Red Indian head.

Harris & Pearson, Limited, Stourbridge—A monthly tear-off wall calendar, the mount of which carries sketches of standard sizes of firebricks.

H. Hendra & Son, Townmead Foundry, Beddington Lane, Croydon—A monthly tear-off calendar surmounted by the picture of an attractive glamour girl.

Holman Bros., Limited, Camborne—A monthly tear-off calendar suspended from a particularly pleasing picture of the harbour at Mevagissey in Cornwall.

W. & J. F. Jones, Limited, Pendlebury Foundry, Pendlebury, near Manchester—A monthly tear-off calendar surmounted by a well-reproduced picture of Helford by Haslehurst.

The Morgan Crucible Company, Limited, Battersea Church Road, London, S.W.11.—A

(*Continued in previous column.*)

Founders' Forum

ORIGIN OF MOULDING SANDS

Q.—Why are certain moulding sands stated to belong to the Bunter series, etc.?

A.—Foundry sands, clay and similar deposits have been formed through the ages by the breaking down of primary rocks. The deposits formed one on top of the other form the strata of the earth and are tabulated by the geologist according to their relative ages, this being determined by consideration of the fossils contained and by the physical relations of the different deposits one to another. There are five main periods in geological time, the oldest being classed as the Archæan period (meaning lifeless). This is followed by the Palæozoic or period of primary life, succeeded by the Mesozoic or age of secondary life. Then there is the Cainozoic period of recent life, finally followed by the present or Quaternary period. Each period, with the possible exception of the latter, covers probably millions of years, and many different kinds of rock formations have naturally been formed during that time, with the result that each period is sub-divided into main rock systems, and these are still further sub-divided into zones and typical beds.

The Scottish "rotten rock" sands, such as Auchen Heath, Drumcavil, Garngad, Avenuehead, etc., are amongst the oldest of moulding sands, and belong to the Carboniferous rock system laid down in the Palæozoic period. This began about 500 million years ago and ended around 50 million years ago. It has been subdivided into six rock systems laid down according to the forms of life then in existence, as follow:—

Cambrian.—The only signs of life on the earth were trilobites, a sort of marine microbe, corals and sponges. Land plants and animals unknown.

Ordovician.—Advent of true corals.

Silurian.—A period of large crustaceans; one attained a length of 6 ft. Insects and fish made their first appearance with the earliest forms of land plants.

Devonian Old Red Sandstone.—Laid down in a period rich in marine life, especially of fishes. Seaweeds and plants allied to equisetum and the tree ferns.

Carboniferous.—The main supplies of coal are obtained from this system. Plant life consisted of ferns, horsetail reeds, gigantic club mosses and a few conifers. Animal life consisted of corals, worms, molluscs, crustacea, insects, fish, gigantic amphibia. Climate probably sub-tropical.

Permian.—Evolution of air-breathing vertebrate life continued. Advance in insect and plant life.

The following Mezozoic period commenced about 50 and ended 10 million years ago. Three rock systems were formed during this time, according to the form of life then existent, which have been called:—

Triassic.—Foremost feature was the advent of the reptilian dynasty.

Jurassic.—Great marine reptiles were numerous, both herbivorous and carnivorous. The plesiosaurus reached a length of 40 ft. and the brontosaurus a length of 60 ft. True birds with many reptilian features existed. Many plants occur, the most important being cycads and conifers.

Cretaceous.—Abundant animal life and the age of reptiles. True snakes first appeared. Climate uniform and warm. Exceptional igneous activity at the close of the period.

The famous red sands of Mansfield, Belfast, etc., have been identified by geologists to belong to the Bunter sandstone series belonging to the Triassic rock system of this period.

Coming to the Cainozoic period, this commenced about 10 and ended between 2 and 4 million years ago. Like the other periods, it is divided into various rock systems, Eocene, Oligocene, Miocene, and Pliocene. This period saw the dawn of recent forms of life and the resemblance of plants and animals to those now living. Erith loam is attributed to the Eocene rock system, whilst the Cornish red and yellow sands were formed at the end of the period in the Pliocene rock system. French red and yellow moulding sands (Oligocene) are intermediate to the above, and were laid down coincident with the appearance on this earth of true apes and the horse and elephant family.

About one million years ago the world entered the last geological Quaternary period, when the Pleistocene and Holocene (or Recent) rock systems were formed. Durham loam is of Pleistocene origin, whilst sea-shore and windblown sands belong to the Holocene system formed about 10,000 years ago. During the Quaternary period there occurred four or five ice ages with intervening genial periods. As a result many glacial deposits, of which Durham loam is typical, came into being. It will thus be observed that the geological terms attached to moulding sands serve to indicate their age and the condition of the earth when they were laid down.

Magnetic Determination of Carbon

(*Concluded from page* 65.)

men was removed from the mould and quenched immediately for higher carbon contents, or left in the mould for a predetermined time—one minute—and then cooled in cold water, for the low-carbon steels. For steels that were known to contain from 0.30 to 0.50 per cent. carbon, but where the amount was known only approximately, a sample was taken following each procedure and the appropriate range and the carbon value determined from the two readings. It was standard practice to break each sample after the reading had been taken in order to be certain that the internal structure was sound.

Performance of Carbanalyser

The magnetic unit shown in Fig. 2 was designed to provide uniform magnetic coupling between the specimen and the yoke, and to require a very small current from the dry cells for its operation. Certain other minor changes from the original design were made at the same time. The procedure described above, however, was used for preparation of the specimens. One of these new instruments was then placed in each of the company's works, and was calibrated there. Reports have been favourable and the Carbanalysers have met the requirements of the operators. The graphs (Figs. 3 and 4) show the results obtained on the works instruments with samples made from commercial heats of steel. It is obvious that the curves would be shifted for steels containing nickel, chromium, etc., and it would be necessary to calibrate the instrument for individual conditions.

(*Continued from next column.*)

vore lighthouse; Robert Stirling, of Perthshire, took out a patent for a hot-air engine; John Basset published a treatise on "Machinery used for Raising Miners in the Hartz"; Sir Henry Bessemer turned to the manufacture of bronze powder and gold paint; Edward Bury contributed a valuable Paper on locomotive engines to the "Transactions of the Institution of Civil Engineers"; and Eaton Hodgkinson wrote on "Strength of Pillars of Cast Iron and other Materials," and was elected a Fellow of the Royal Society, being awarded the Society's gold medal.

Centenaries in the Iron and Steel Industry

One of the most interesting anniversaries to be commemorated during 1940 is the bicentenary of the birth of Henry Cort, an ironmaster whose name is outstanding amongst inventors in the iron and steel industry. Finding that Russian iron was preferred to British, and being convinced that British could be improved, he leased a forge and mill near Fareham where, in 1784, he patented a process for purifying iron by "puddling," or converting pig-iron into malleable iron. He was subsequently ruined by the prosecution of his partner, Adam Jellicoe, for embezzlement of Navy funds, but was pensioned on the representation of Pitt. He is best known as the inventor of the grooved rolling mill.

In the year of Cort's birth Benjamin Huntsman set up, at Sheffield, his famous works for cast steel—the first production of perfectly uniform steel. He had been hampered by the poor quality of steel obtainable for making watch springs, and spent many years in experiments. He had great difficulty in persuading Sheffield cutlers to use his steel, which was much harder than any they had had previously. In fact, for a time his output went to France, and the cutlers, becoming alarmed at the general preference for cast steel, attempted to get Parliament to prohibit the export, but, being unsuccessful, had to use it themselves.

There occurs on June 19 the centenary of the death of John Cockerill, who, with his brother Charles, established at Seraing in Belgium what rank amongst the most extensive ironfoundry and engineering works on the Continent. There died on October 26 in the same year (1840) William Hazeldine, a famous ironfounder, who furnished the ironwork for the Menai and Conway Bridges, and the iron arch for Tewkesbury Bridge. In 1780 he was superintendent for the erection of some machinery at Upton Forge, in Shropshire, and subsequently built a foundry in the same county. He also worked under Telford.

Maxim's Versatility

Among celebrities born a century ago was Sir Hiram Stevens Maxim (February 5), who, besides his famous gun, invented a flying machine, smokeless powder, an automatic sprinkler, and a density regulator for equalising the illuminating value of coal gas. He also made dynamo-electric machines, and incandescent lamp carbons, and took out many patents in electrical machinery.

There occurs on March 31 the centenary of the birth of Sir Benjamin Baker, who, beginning his career as an apprentice in an ironworks, was concerned, in partnership with Sir John Fowler, in the construction of London's underground railway system, was responsible for the Assuan Dam, and (with Barry) the Avonmouth Docks, and was knighted for his share in the construction of the Forth Bridge.

George Albertus Cox, who was born on May 7, 1840, was a Canadian Senator, and was a director of the Dominion Coal Company, and of the Dominion Steel Corporation. On the 14th of the same month was born Sir Charles Douglas Fox, who was Vice-President of the Institution of Civil Engineers, was joint engineer to the Mersey Tunnel and Hawarden Bridge, and was the inventor of a safety guard used on Swiss railways and on the Snowdon mountain line.

By 1840 good steel was being made from English iron by Heath's process of combining carbon with manganese to produce a carburet. The Varteg Ironworks were closed that year; Alan Stevenson laid the first stone of Skerry-

(*Continued at foot of previous column.*)

The Week's News in Brief

Trade Talk

EMPLOYEES of Shaw Glasgow, Limited, Maryhill Iron Works, Glasgow, contributed £229 to their hospital fund last year.

GENERAL REFRACTORIES, LIMITED, have removed their London office from Russell House, Adam Street, Adelphi, to Atsor House, Aldwych, W.C.2. The telephone number is Holborn 8002.

NEW ZEALAND GOVERNMENT purchases in Great Britain during December were worth £86,000. The material bought chiefly comprised various electrical machinery and supplies obtained in Yorkshire and Lancashire.

ACCORDING TO Mr. H. H. Shepherd's monthly Presidential letter to the members of the East Anglian Section of the Institute of British Foundrymen, there is every prospect of an informal meeting of the Section being held in the near future.

J. & R. FORGAN, LIMITED, of Port Pirie, South Australia, recently completed an order for two ladles each weighing about 15¼ tons. The castings were 10 ft. in diameter, 10 ft. deep and 3 in. thick, and are probably the heaviest so far made in South Australia.

SIR JOHN GILMOUR, Minister of Shipping, is expected to make a statement to Parliament shortly on the Government's shipbuilding programme and on the proposed control of all shipping. It is believed that shipbuilding yards which were closed during the depression period under the rationalisation scheme will be reopened.

ARRANGEMENTS have been entered into between McPhersons, Pty., Limited, of Melbourne, and William Cable & Company, Limited, engineers, Wellington, New Zealand, for the establishment of a company in New Zealand to manufacture bolts and nuts. Capital will be £50,000, to be held jointly by the two firms. The new company will trade under the name of Ajax Bolt & Rivet Company, Limited.

THE THIRD Manchester Association of Engineers' Annual Lecture will be presented to members of that Association on February 9, at 7.30 p.m., at the College of Technology, Sackville Street, Manchester. The lecturer will be Prof. A. H. Gibson, Beyer Professor of Engineering, the University of Manchester, and Director of the Whitworth Laboratories, and his subject will be "The Use of Models in Engineering."

WITH the co-operation of the National Farmers' Union, a special test survey in connection with the national campaign for the collection of scrap iron and steel has been made in Gloucestershire, and proved so successful that a similar survey is to be made of all agricultural counties. Farmers and landowners in the more remote districts are being invited to lend every assistance in their power. It is felt that much useless scrap must be lying derelict along hedgerows, in fences, barns, stables, and other outbuildings, as well as in cellars and in attics.

CLAIMS for increased wages were put before the Engineering and Allied Employers' National Federation on January 10 by deputations representing the Amalgamated Engineering Union, the National Union of Foundry Workers, and the Confederation of Shipbuilding and Engineering Unions. Mr. J. Tanner, president of the A.E.U., argued in support of an increase of 10s. a week that a substantial advance was justified by the activity of the industry and the increasing cost of living. Sir Alexander Ramsay, director of the employers' federation, replied and said in each case that the claim would be referred to the constituent bodies of the federation. The conference was thereupon adjourned.

FIRMS at Coventry, Walsall, Dagenham, Darlaston, and other towns are reported to have been seeking skilled workmen in the Sheffield district. It was reported recently that men had left to work in Coventry, but there is nothing to support the suggestion that skilled men are moving to other districts in numbers sufficient to disturb Sheffield production. Sheffield engineering employers, all of whom could find jobs for more skilled men are, as an organised body, opposed to any of their number seeking men in other districts where it is known that a similar shortage of skilled workers obtains. The associated employers in Sheffield adopted the policy of no indiscriminate advertising in other districts, particularly districts engaged on national production, and that understanding has been kept.

THE report of the Koninklijke Nederlandsche Hoogovens en Staalfabrieken for 1938-39 states that the total output of pig-iron during the year was 275,712 metric tons, as against 298,928 tons in the previous year. Of the output, 223,046 tons, or about 75 per cent., was sold abroad. The net profit was 815,817 fl., and for the first time since the establishment of the company in 1918 a dividend has been paid to the shareholders, *viz.*, 3 per cent. The immediate outlook is not regarded as bright, since the bulk of the output has been sold abroad, principally to Belgium, Germany and the Scandinavian countries, delivery of which has been made difficult by war conditions, while imports of raw materials, mainly iron ore from North Africa, Spain and Sweden, have become irregular. It is feared that if the war lasts a long time the whole industry will have to curtail its operations seriously, if not close down altogether.

Personal

MR. A. H. WOLSELEY, managing director of Charles Clifford & Son, Limited, Birmingham, has completed 60 years' service with the company.

CAPT. RICHARD C. PETTER and Mr. Charles L. Hill have been elected to the board of the Brush Electrical Engineering Company, Limited, Loughborough.

MR. C. D. POLLARD, hitherto manager of the steel foundry of Qualcast, Limited, of Derby, has been appointed general foundry manager, and is in charge of the company's three foundries.

MR. FREDERICK CHARLES STEWART, chairman of Kelvin, Bottomley & Baird, Limited, and a director of Brown Bros. & Company, Limited, has been elected to the board of the Clydesdale Bank.

COL. H. B. SANKEY has been made a Justice of the Peace for the County of Stafford. Col. Sankey is managing director of Joseph Sankey & Sons, Limited, Bilston, and is a director of John Lysaght, Limited.

MR. PERCY PRITCHARD (Birmingham Aluminium Castings Company, Limited) and Mr. J. T. Kay (National Union of Foundry Workers) have been appointed members of Midland Area Advisory Board, formed to assist in the development of industrial production for war purposes.

DR. C. H. DESCH, F.R.S., has retired from the post of Superintendent of the Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, having attained the normal age limit. Dr. Desch will be succeeded by Dr. C. Sykes, D.Sc., of the Metropolitan Vickers Research Laboratories, who will take up his duties at Teddington on March 1 next.

LORD DUDLEY GORDON has been nominated as president of the Federation of British Industries for the coming year. An ex-president of the British Engineers' Association, he has served for a number of years on the Grand Council of the Federation, and was a few months ago appointed deputy-president. He is chairman of J. & E. Hall, Limited, engineers, of Dartford.

MR. ALAN E. PICKLES, assistant sales manager of Birmingham Electric Furnaces, Limited, has left England to take up a new position as general manager of a branch which is to be established in Sydney, N.S.W., Australia. Mr. Pickles, who is a graduate of Birmingham University, has been associated with Birlec for more than ten years. Two of the company's expert employees—a furnace designer and a furnace erector—have preceded him to assist in the new enterprise.

MR. J. H. CROSSLEY, B.Sc., sales manager of Birmingham Electric Furnaces, Limited, has returned to England by air from South Africa, after an extensive tour of industrial plants in the Union and Rhodesia. During the course of this trip, Mr. Crossley supervised the erection of the largest electric arc furnace yet installed in South Africa—a standard model in the range of Birlec Lectromelt furnaces with a capacity of 8 tons and a rating of 3,600 k.v.a. During his tour Mr. Crossley was received in audience by General J. C. Smuts.

MR. A. WYNN, general manager of the Midland Electric Manufacturing Company, Limited, of Birmingham, has been appointed joint managing director of the company in association with Mr. W. L. Barber, the founder. Mr. Wynn's service with M.E.M. dates back to 1923, since when he has held the positions of production engineer, works superintendent and assistant general manager. Mr. W. John Barber has been appointed to the board of directors of M.E.M. from January 1 and will in future act as works director. He joined the company in 1935, and has latterly acted as works superintendent.

MR. W. R. LYSAGHT, the chairman and a managing director of John Lysaght, Limited, tendered his resignation of both offices at a board meeting in London recently. He has been associated with the firm, which was founded by his uncle, for nearly 63 years. Sir David R. Llewellyn, Bt., the deputy chairman, was elected chairman and a managing director, and Mr. S. R. Beale, chairman of Guest, Keen & Nettlefolds, Limited, deputy chairman. Deep regret at his decision to retire was expressed by Mr. Lysaght's co-directors, who elected him President of the company. Mr. Lysaght, who is aged 81, has been responsible for all the big developments undertaken by the company. It was he who moved the works to Newport, opened the large steelworks at Scunthorpe, and started the big works in Australia.

Will

IRVING, B., former managing director of Sir W. G. Armstrong Whitworth & Company, Limited, and director of the Standard Pulverised Fuel Company, Limited, and Worthington-Simpson, Limited £11,397

Obituary

MAJOR W. H. DICK, managing director of Wailes Dove Bitumastic, Limited, of Hebburn-on-Tyne, died last week, aged 60.

MR. DAVID QUINTIN BELL, managing director of C. & H. Crichton (1921), Limited, engineers and ship-repairers, of Liverpool, has died at the age of 58.

MR. SUMMERS HUNTER died recently at Stocksfield-on-Tyne at the age of 83. He was formerly chairman and managing director of the North-Eastern Marine Engineering Company, Limited, Wallsend and Sunderland, and a prominent marine engineer. When he retired in 1929 he had completed 49 years' association with the company. He was a native of Inverness and went to the Sunderland works in 1880. He was appointed general manager at Wallsend in 1895, director four years later, managing director in the following year, and chairman in 1920. He received the C.B.E. in 1918 in recognition of his services during the last war and was President of the North-East Coast Institution of Engineers and Shipbuilders from 1908 to 1910.

Contracts Open

Bradford, January 22—Cast-iron gullies, etc., for 12 months ending March 31, 1941, for the Corporation. The City Engineer, Town Hall, Bradford.

Cairo, February 6—Heavy cast-iron pipes, etc., for the Main Drainage Department of the Egyptian Ministry of Public Works. (D.O.T. reference: T. 15042/40.)

London, W., January 29—Ironwork for sewers and iron castings, etc., for 12 months or six months from April 1, for the St. Marylebone Borough Council. The Town Clerk (Room No. 31), Town Hall, St. Marylebone, London, W.1.

Forthcoming Events

JANUARY 26.

Manchester Association of Engineers:—"Equipment for Handling Lock Gates, Salvage Work and Heavy Traffic Lifts on the Manchester Ship Canal," Paper by W. G. Smith and R. Parker, at Engineers' Club, Manchester, at 7.15 p.m.

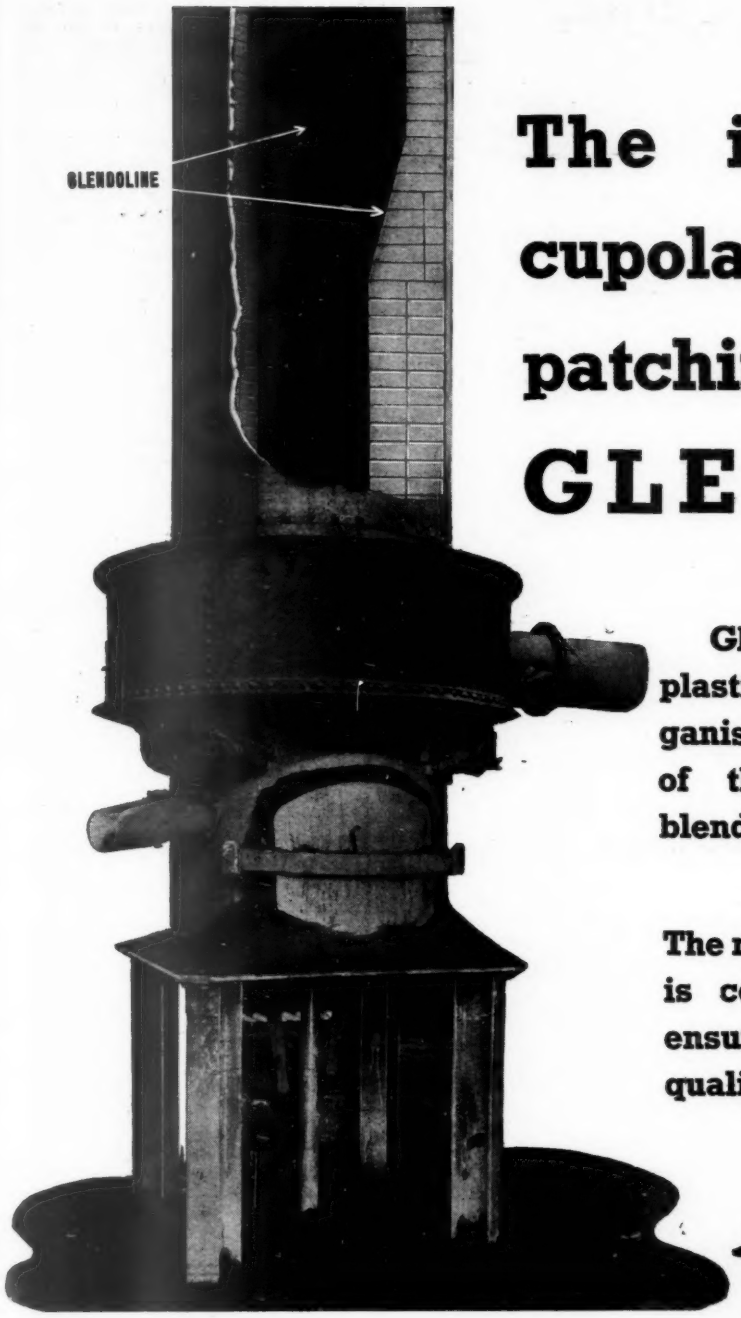
Institute of British Foundrymen

JANUARY 26.

Falkirk Section:—Joint meeting with Institute of Vitreous Enamellers. "Some Principles of Cast Iron Enamelling," Paper by Dr. G. T. O. Martin, at Temperance Café, Lint Riggs, Falkirk, at 7 p.m.

JANUARY 27.

East Midlands Branch:—"Cast Iron with Relation to Machine Tools," Paper by P. A. Russell, at Technical College, Derby, at 2.30 p.m.



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Raw Material Markets

Conditions in the iron and steel markets continue to be very active. Producers are making every effort to satisfy requirements. With costs of production steadily rising, it is likely that prices will be revised in the near future. No official intimation is yet to hand, but there is a heavy burden of increased costs at present resting on makers' shoulders, and it is obvious that some part of this at least must be passed on to the consumers. Most iron and steel makers are already committed for many months to come, and the difficulties in the way of placing additional orders are considerable. The Iron and Steel Control, which is responsible for maintaining an adequate supply of material to firms engaged on the production of armaments, etc., makes a very close scrutiny of the circumstances surrounding fresh applications, and requires evidence that the supplies are to be put to good use.

Pig-Iron

MIDDLESBROUGH—The demand for special irons, hematite and basic is such that no resumption has been made in the production of iron for the foundries in this area, which continue to obtain their requirements from the Midlands. There is a stronger call for foundry iron now that local works have better order-books, but they are obtaining supplies quite freely. Steel plants in the district absorb the full outputs of basic iron, while there continues to be an expanding demand for hematite. Stocks of the latter are now practically non-existent, and current production is thus severely taxed. No increase in the make is yet reported, but some additional furnaces will have to be blown-in if production is to keep level with consumers' needs.

LANCASHIRE—Applications for licences for iron continue to be insistent, but supplies are being despatched to users at a good rate, and consumers engaged on work of a national character especially are receiving satisfactory attention. Stocks at the consuming plants are, of course, within narrow limits, as these have had to be used up before fresh orders can be accepted by the ironmakers. Satisfactory employment is general in this district, but certain jobbing foundries are not working to capacity, while the light-castings trade still is not really active. The latter, however, is expecting to receive an increasing share of work in connection with the Government's defence programme.

MIDLANDS—The effect of the war on the demand for high-phosphorus iron has been most marked, and business in this section is now very brisk. The distribution of this material is now in the hands of the Control authorities, and thus users are being assured of sympathetic consideration in their claims. Stocks are low and most users are now relying on current deliveries. Many makers of light castings are able to devote a large part of their outputs to the ordinary domestic trade at home and to the satisfaction of export inquiries, as the Government's use of this trade for defence purposes is, as yet, limited. Heavy engineers, on the other hand, are extremely active on work of first importance, and the demand for pig-iron from these concerns continues to expand. Generally, heavy engineers are using hematite and low-phosphorus iron. Supplies of the latter are now more freely available, but the former is fully taken up and stocks are negligible, although the situation is expected to improve in the near future.

SCOTLAND—Very active conditions prevail at pig-iron using establishments here, and the outlook for the future is very satisfactory, as order-books already extend over several months ahead, with the prospect of further business being placed. House-building continues to be very quiet, and is causing a continued slump in the light-castings trade. Later in the year it is anticipated that there will be more defence work available for the light-castings trade. Basic iron is in very strong demand, and it is as well that substantial tonnages are being regularly imported.

Coke

Deliveries of foundry coke are being taken up very freely, and the ovens continue to be busy. Many consumers are covered over several months ahead, the contracts containing a rise-and-fall clause. For delivery to Birmingham and Black Country stations, the price of Durham best foundry coke is 53s. per ton.

Steel

With the production of steel running at a record level, the needs of the consuming trades appear to be well covered, but it must be appreciated that the war effort involves a demand considerably in excess of peacetime requirements. Business in all sections is strong, and primary consideration is, of course, given to users connected with the war requirements. Thus, some commercial business is having to be neglected, while only limited attention can be paid to the export market. Costs of production continue to rise, and some consideration will shortly have to be given to prices, which are at present only 0.3 per cent. above prices ruling at the end of 1938.

Scrap

The pressure for deliveries of iron and steel scrap remains insistent, and every effort is being made to raise the rate of deliveries, especially in the steel-works. Home sources of supply are being canvassed through the campaign of the British Iron and Steel Federation, which goes on apace, but if the supply of scrap is to be sufficient to meet the demand additional tonnages will have to be bought overseas. Imports are arriving, but it is hoped that in the near future the rate of shipments to the United Kingdom will be greater.

Metals

A seasonal quietness continues to pervade the non-ferrous metal markets. A moderate turnover has been seen in tin, the only metal free from the shackles of the Control authorities, but licences for the supply of copper, spelter and lead appear to be somewhat reduced. The Ministry of Supply has appointed Mr. Frank Baer, a director of Metal Traders, Limited, and Mr. H. C. Street as members of an advisory committee to the Non-Ferrous Metals Control. They will consider problems arising out of wartime operation of the London Metal Exchange.

Copper—There is little of interest to report in connection with copper; consumers are taking up fresh tonnages through the Control, but there does not seem to be any rush to obtain new licences at the moment. The first part of the year is usually taken up with stocktaking, but in the present instance the position is quite different from that normally experienced at the New Year. In order to distribute available supplies of copper in an equitable manner, the Control insists that no licences will be granted until the applicant can prove that he has an immediate use for the metal in connection with work of national importance. Most consumers worked off their stocks some time ago, and are now relying on current deliveries. On Monday, the American Temporary National Economic Committee began its investigation into the United States copper industry. The interference on the part of the U.S. Government is deplored in many quarters of the industry, where it is stated that the men entrusted with the investigation, viz., research economists, are not suitable to undertake such a task, which should have been carried out by qualified mining engineers.

Tin—This market may now be said to have settled down after having been granted its freedom, and in a very satisfactory manner, too. The price of the metal in London has, of course, appreciated, but following the first effects of the dropping of the control the increase in price is not at all unreasonable. Speculation in the market, also, is at a low ebb, which is something of a surprise to many people. Supplies are coming through well, and the output of the metal is very gratifying. Shipments to the United Kingdom are arriving steadily, and only about two vessels containing tin are, it is believed, on the sea bed as the result of enemy action. And these two ships were only carrying about 44 tons of tin between them.

Metal market prices for tin were as follow:—

Cash—Thursday, £246 10s.; Friday, £243 5s.; Monday, £242 15s.; Tuesday, £242 5s.; Wednesday, £241 15s.

Three Months—Thursday, £245; Friday, £242 15s.; Monday, £241 15s.; Tuesday, £242; Wednesday, £241 5s.

Spelter—In this country there is little of interest to report. Consumption is heavy, but the recent holidays and inventories doubtless had their effect on the use of the metal. Most consuming works are busily employed, and they are expected to be so for a considerable time to come. The chief demand is in high-grade metal, but g.o.b. metal, too, is well taken up. In the United States, stocks are reported to be steadily rising.

Lead—There continues to be a good demand for this metal, mainly in connection with the Government's armament programme. Most other users are quietly occupied, especially the pipe and sheet makers, who have been hit by the lack of animation in housebuilding, while many paint makers, too, are slack.

Scrap—The shortage of non-ferrous scrap, which has been so apparent recently, has been less noticeable since the prices of copper were increased. Supplies are still by no means free, however. The maximum prices introduced by the Control are adhered to strictly.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

513,316. DOVE, J. A. Method of jointing sheet metal.

513,319. SOC. ANON. DES HAUTS-FOURNEAUX DE LA CHIERS. Apparatus for the determination of the resistance to fracture of test-pieces and the like.

513,359. NACHTMAN, J. S. Apparatus for continuously electroplating strip metal stock.

513,363. DANGERFIELD, H., and LLOYD, H. P. Machinery for producing corrugated sheets.

513,391. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE SAINT-GOBAIN, CHAUNY, & CIREY. Salt-bath furnaces.

513,411-2. DANGERFIELD, H., and LLOYD, H. P. Machines for producing corrugated sheets.

513,511. STEVENS, A. H. (Winchester Repeating Arms Company). Thin-walled, seamless heat-exchanger tubes.

513,517. KAUFMANN, H. Producing polish-like coatings on metal.

513,522. DUFFIELD, F. L. Production of iron from ore.

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